PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY, Limited,

167-177 TIMES BUILDING, NEW YORK.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, Room 28, Hathaway Building, 620 Atlantic Ave., Boston.
Western Office, 465 The Rookery, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION, IN ADVANCE, ONE YEAR, $3.

(Including Postage in the U. S., Canada or Mexico.)
IN CLUBS of four or more, $2.50 a year each; with a free extra copy to the getter up of a club of 8. Foreign subscription, $6 a year.

In requesting your address changed, give **old** *as well as new address.*

ESTABLISHED 17 YEARS AGO, THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America and has well maintained its lead. It has the LARGEST CIRCULATION of any electrical periodical in the world, and is the BEST ADVERTISING MEDIUM.

Correspondence, views and opinions on all topics within the province of this journal are cordially invited from any part of the world. We will thank readers to forward to us—**promptly** as they occur—**Items of News,** or information relating to any application of Electricity, also marked copies of their local papers containing anything likely to interest electricians. Anonymous communications cannot be noticed, nor can rejected manuscript be returned, unless accompanied by the necessary postage when received.

Advertising Rates are much lower than those of any other similar publication, circulation and standing considered, and vary according to space, position and number of insertions. Quotations promptly furnished.
Situation or Help Wanted advertisements $1 to $2 an insertion, according o length.

Address all communications to

THE W. J. JOHNSTON COMPANY, Ltd.
Times Building, New York,
OR ANY OF THE BRANCH OFFICES.

VOL. XVII. NEW YORK, APRIL 4, 1891. No. 14

CONTENTS.

EDITORIAL: PAGE.
Paragraphs ... 253

ILLUSTRATED ARTICLES:
The Course in Electrical Engineering at Purdue University .. 255
The Short Gearless Street Railway Motor ... 256
The Dow Turbine Operating a Dynamo ... 256
Notes on Electrostatic Wattmeters ... 257
The Kingdon Inductor Dynamo ... 257
The Magnetic Circuit of Transformers: Closed versus Open, by S. Evershed ... 258
The Westinghouse Street Car Lightning Arrester ... 259
Three Styles of Cartwright Roseties ... 259
The Woodbury Engine ... 259
Transformer Distribution, by J. Swinburne ... 260
Simple Graphic Method of Calculating Resistance of Divided Circuits, by P. J. McFadden ... 261
Projector with Concentric Carbons ... 262
The King Annunciator ... 262
The Electro-Calcium Lighting Apparatus ... 262
The Bates Sand Distributor ... 262
A Diminutive Bell ... 262
A Street Railway Pole Ratchet ... 263
The Model Shade Holder ... 263
An Insulated Screwdriver ... 263
The Porter Motor ... 263

MISCELLANEOUS:
Phenomena of Alternating Currents of Very High Frequency, by Elihu Thomson ... 254
Reply to Mr. Robert Shand on Variations of Current in the Primary of Open Circuit Transformers, by Wm. Stanley, Jr. 254
Rapid Transit in New York ... 254
Electrical Equipment of McVicker's Theatre, Chicago ... 254
The Striking Distance of Alternating Electromotive Forces, by Robert Shand ... 256
Repairs on Incandescent Lamps ... 259
Programme of the Patent Centennial Celebration ... 261
A Simple Electrical Saw ... 263
The Flow of Current Through an Electric Arc ... 263
The Brooks System Abroad ... 262
The Electrical Association of Pennsylvania ... 263
Launch of the First Government Electric Pinnace ... 263

FINANCIAL INTELLIGENCE: The Electrical Stock Market, 264; New Incorporations, 264; Affairs of the Companies, 264.

SPECIAL CORRESPONDENCE: New York Notes, 264; New England Notes, 264; Western Notes, 264; Southern Notes, 264; English Notes, 264.

ANSWERS TO CORRESPONDENTS ... 266

NEWS OF THE WEEK: The Telegraph, 266; The Electric Light, 266; The Electric Railway, 266; Personals, 266; Legal Notes, 267; Miscellaneous Notes, 267.

INDUSTRIAL AND TRADE NOTES ... 267

BUSINESS NOTICE ... 267

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 268

A Pertinent Decision.

A RATHER interesting decision was rendered in the Court of Common Pleas a few days ago. The question involved was the validity of a contract between one of the electric lighting companies in New York City and one of its subscribers. The house wiring was paid by the subscriber, but the connections were made at the expense of the company. For about six weeks all went well; then the city authorities cut down the connections. On this interruption of his lighting facilities the subscriber refused to pay for the light that had already been furnished him, on the ground that the unlawful use of overhead wires in making the connection invalidated the contract. This unique defense was very properly upset by the court on the general ground that the contract for lighting was entirely proper, light had been furnished, and the means taken to do it had no special bearing on the validity of the contract. There is substantial justice in this. It would be hard indeed if the electric light companies were subjected not only to the loss of continued revenue by the cutting down of their wires, but in addition were deprived of payment for the work already done on such grounds as those noted.

A Steam Turbine in Electric Service

WE illustrate on another page a very neat combination of the Dow steam turbine, recently described in our columns, with a dynamo intended to run at the high speed of 10,000 revolutions per minute. In this case dynamo, governor and base were those belonging to a Parsons turbo-electric generator that has been in service in the United States Torpedo Station at Newport. The Dow turbine made such a good name for itself in use on the Howell torpedo that the officers in charge thought best to replace the Parsons turbine by it, thus securing a much more compact apparatus. The normal speed of the motor is so high that it could not be readily applied to most of the present dynamos. But the question immediately arises whether by utilizing such a machine and such speeds it may not be possible to make very simple and effective dynamos of high efficiency. The Faraday disc type of machine lends itself very readily to such an arrangement, and 110 volts could be very easily obtained from a revolving disc not more than 30 inches in diameter at a speed of 10,000 turns per minute. Of course the main difficulty in such a machine is the collection of the current from the flying periphery. Of devices for this purpose none is more ingenious than that of Mr. Tesla, who has employed two discs united by a steel belt, that can serve as driving gear for one as well as collector for both. Perhaps other simple means may be devised for accomplishing the same purpose; but at all events the practicability of these enormous rotative speeds opens rather a new field in dynamo construction. Under such circumstances the use of iron in the armature may become totally unnecessary, and hence the losses from hysteresis could be entirely avoided. So far as the motor is concerned, the mechanical difficulties seem to be completely overcome, and a little ingenuity will undoubtedly do as much for the dynamo.

A Fountain of Electricity.

AN amusing report comes from Boston that the much-abused trolley wire has appeared in the rôle of a public benefactor, a sort of good genius ready to lend a helping hand at the most unexpected and opportune times. This somewhat apocryphal book of electrical romance states that a certain citizen living along the line of the West End road found an ever-active and unceasing fount of electricity in his cellar, coming from one of the iron posts of the railway company and flowing free and frolicsome into his private domain. He promptly corraled the current, and, charging a storage battery with it, lights his house, runs motors, bells and burglar alarms, and, for all we know to the contrary, sublets power to all the surrounding region. The item further states that the railway company is powerless to prevent the leak—a statement that, coming as it does from a daily newspaper, must of course be believed by those who desire. Nothing can show the popular ignorance of electricity more clearly than this frisky item from the Hub of the Universe. A thoroughly trained and well-educated reporter would not have stopped at such commonplace and altogether prosaic evidence of electrical leakage. He would have seen the magnificent possibilities of the situation and developed them. The current entering the cellar should have found its way into the pork barrel that furnishes the invitable concomitant of the cosmical bean, and cooked the contents ready for use. Thence it should have proceeded upstairs along the walls, and, heating them by its passage, rendered the furnace unnecessary. Thence it might have meandered to the bedroom of some venerable, hopeless invalid and brought him the activity of youth; and, if this is not enough to make the fact of occasional leakage evident and impress it on the public mind, the current might have been led along other water-pipes to the gilded dome of the State House, to make it unapproachable by profane hands by day and a glowing torch of St. Elmo's fire by night. It is positively enough to make an electrician sick to think of the glorious opportunity that the romancer from Boston let slip through his fingers, and by this witness it shall never come back to him.

The Short Gearless Motor.

ON another page we give a brief description of a new street car motor just being brought out by the Short Electric Railway Co. It is the first gearless motor to appear in American practice, and as such has an interest of its own quite independent of what its actual performance may be. Of this we have as yet no details. Of course it is quite practicable to design a street car motor for a speed not exceeding 100 revolutions per minute, but two very pertinent questions immediately arise: First, can such a motor be made efficient? and, second, if efficient, will it be of reasonable weight and bulk? As regards the former, a low-speed motor can unquestionably be made efficient; as regards the latter, it is possible, but exceedingly difficult. How successful the attempt of Mr. Short to give a practical answer to both has been only further details and exact tests are capable of showing. The problem is a difficult one, but, as we have often said before in these columns, is not insoluble, as a few months or years will probably teach us from experience. Given a motor running at a low speed, and it can be placed either directly upon the axle or communicating power directly to the axle. Just now there is considerable discussion as to the relative merits of these two plans. Either can be made effective enough, but the difficulties of placing an armature directly upon the car axle seem to us enormously overrated. When armature winding was an art comparatively new, and little was known of proper devices for insulation, the point might have been well taken; but at the present day we see no reason why there should be any particular difficulty in making an axle out of the armature spindle without fear of the insulation breaking down from vibration. It is entirely practicable to make armature conductors mechanically solid with the core, as can be done, for instance, with the Wenstrom construction, and to insulate them effectively. Whether the form of winding adopted in this Short motor is well adapted to stand vibration may well be open to question; but we are certainly glad to see the experiment tried fearlessly, for such is really the only way to settle disputes which turn on mechanical questions of fact alone. The slow-speed motor is rapidly coming to the front, and whether it is placed directly on the axle or drives it through a single gear, or connecting rods, it is still a great improvement over the motors most generally used. In mechanisms such as are used for electric street railway work, we hold that every moving part beyond what is absolutely necessary is an abomination. If it is possible to dispense with all of them, save the armature or field magnets, so much the better.

Transformers Again.

AN interesting note from Mr. William Stanley, Jr., takes sharp exception to the conclusions drawn by Mr. Shand in a recent number of THE ELECTRICAL WORLD. The point at issue is the size of the so-called leakage current in transformers having an open magnetic circuit. And just here let us protest against the term "leakage" current as applied to this particular quantity. It is often used, and is somewhat convenient to avoid circumlocution, but it certainly conveys a false impression at first sight. If the current that flows on open circuit through a transformer is called "leakage" we deprive ourselves of any proper name for the real leakage phenomena that occur between primary and secondary, and between each of these and the ground. But this aside it seems to us that the whole question of open and closed circuit transformers is in a very muddled state. It has been the subject of violent discussion during the last year, and the question has virtually resolved itself into one of fact. The advocates of the open circuit transformer claim that they can make it efficient; the more numerous friends of the closed circuit transformer claim that in their hands the open circuit type is not efficient; meanwhile neither party casts very much light on the facts. Looking at the case in a broad, general way, the state of things is somewhat as follows: In the ordinary parallel system of distribution the mains are connected through the primary coil of the transformer, and the size of the current that flows across from main to main is determined by two things—the resistance of the primary circuit and its self-induction. If either of these factors is large enough in value, the current thus lost can be reduced to a very small quantity. In practical transformers it varies from, say, a twentieth of an ampère to several tenths of an ampère. Now, with a moderate resistance in the primary coil of the transformer, according to the usual practice, the size of the "leakage" current is approximately inversely proportional to the impedance of the transformer. Consequently, if the magnetic circuit is bad the "leakage" will be large. Both low magnetic conductivity and leakage of field tend to lessen the effective electromotive force of self-induction, and hence let more current through the primary coil. From these considerations it is evident that with a given winding the "leakage" current will depend on the conductivity of the magnetic circuit, whether it be of the closed or open form. So far, then, as efficiency with respect to hysteresis losses is concerned, the problem is so to dispose the iron core as to secure for the converter the maximum self-induction with the minimum of hysteresis. But, in general, the less iron used the more copper will have to be used to secure the same impedance and immunity from "leakage" currents. The question is thus reduced to the following: Is it possible to construct a reasonably efficient open circuit transformer without using so much copper to compensate for the lack of iron as to produce an excessive drop of potential when load is put on the secondary? This is not a question to be decided by any one test. A final solution of it demands that the same skill and care should be put into the design of the open circuit transformer as is given to the closed circuit type. A hasty experiment with either will inevitably lead to fallacious results; and with respect to the discussion of which we are speaking, Mr. Shand's criticism of Mr. Stanley's somewhat unguarded statement was, so far as the facts given are concerned, just, but was itself unguarded so far as the question of regulation is involved. The proper way to settle such a dispute would be to have Mr. Swinburne, or some other designer who has given particular attention to open circuit transformers, try his hand at the design of one which should have impedance enough to cut down the "leakage" current and an amount of copper sufficiently small to bring the drop of potential within reasonable limits.

Phenomena of Alternating Currents of Very High Frequency.

BY ELIHU THOMSON.

In regard to the comments of Mr. Tesla published in your issue of March 18, concerning my note in your issue of the 11th, I think it desirable that I should make a few remarks. Mr. Tesla appears to infer that my investigation of the properties of alternating currents of high periods must have been subsequent to the note which was published in *The Electrician* (London) a few months ago stating that I had constructed a high-period machine. I would say that as soon as that machine was completed I made quite a number of investigations in relation to the properties of these currents, but did not have time to put them in shape for publication. In regard to the experiments with the incandescent lamp bulb and the strip of filament mounted on a single wire I cannot agree with Mr. Tesla at all that conduction through the glass has anything to do with the phenomenon it presents. It is well known that an incandescent lamp bulb if held in the hand is capable of acting as a Leyden jar and will receive and retain a charge from a static machine of very high potential, and that a very violent Leyden jar shock, with a long spark, may be obtained by bringing the free hand toward the neck while holding the bulb after charging, as mentioned. If conduction through the glass were a possibility this action could not occur.

Mr. Tesla thinks that I have misunderstood his statement about the limit of audition. From my point of view I think that he has misunderstood *my* statement about it. He had stated that he had experimented with 10,000 to 20,000 alternations per second. I pointed out that this would correspond to 5,000 to 10,000 complete waves of sound, and equally—I may now say—complete waves of current. The limit he had adopted or suggested was about 10,000 waves a second. It is evident that his experimenting with from 5,000 to 10,000 complete waves would be working below this limit of audition, even taking the low value which he had suggested for it. I have heard sounds of 20,000 complete waves per second. The physical cabinet of the Central High School, at Philadelphia, contained, at the time of my connection with the institution, apparatus which enabled a test of one's hearing powers in this respect to be easily made.

I agree with Mr. Tesla that the success of an arc light system depends upon good management, and I include in the term "good management" good design, good construction, good supervision and good commercial work, which include the ability to stand considerable bad management in the running.

Five or six years ago it occurred to me to try the construction of a dynamo for constant current in which the armature coils were of highly efficient type; that is, of comparatively short wire length for the voltage and moving in a dense magnetic field. Exteriorly to the coils and to the field I had placed (in the circuit of each coil) an impedance coil, which consisted of an iron core wound with a considerable length of wire and connected directly in circuit with the armature coil. I thus obtained, as I thought, the property of considerable self-induction, along with efficient current generation, and by separate devices. I expected that possibly the effects would be very much the same as those obtainable from the regularly constructed arc apparatus. In this I was disappointed. The effect was to shift the diameter of commutation forward and to lower the capacity of the machine, while the properties otherwise were not so greatly changed. The requirement in the arc machine is simply that there shall be a droop or dip in the characteristic curve at about the point of normal current, and at a rate dependent upon the character of the lamps used with the machine. Differentia lamps require for stability less droop or dip than lamps feeding entirely by the shunt or derived circuit. Without doubt arc machines give better effects when the field magnets are in series, not only on account of the resistance of such magnets, but also because of their self-induction tending to smooth out and obliterate vibrations or undulations of current which would otherwise have a direct passage from the commutator brushes to the circuit.

Mr. Tesla has evidently misunderstood my meaning when I spoke of the introduction of a coil of large self-induction in series with arc lamps as not affecting their feeding. I had no reference to any instability of current "involving large variations and occurring at large time intervals" in this case, as the machinery I used was of a stable character, and did not give rise to the instability at which he here seems to hint. I meant that a coil of large self-induction cut down or wiped out vibrations or undulations of current, and reduced them to a very slight amount,—*i. e.*, prevented them from existing in the circuit,—just as such coils will wipe out the waves of speech in a telephone circuit, only the effect here is of course on a larger scale.

In relation to the feeding of a lamp which operates by a clutch I do not deny that a slight vibration of the parts will or may benefit the feed, but I think the same slight vibration will benefit the feed of the clockwork lamp also. On this point Mr. Tesla contented himself by simply saying that he cannot agree with me, and that he thinks these vibrations do not at all benefit a clockwork lamp. I disagree with him here because I think they *must*, as the vibration tends to keep all the moving parts free to act and voids the sluggish effect of starting friction. In the clutch arc lamps of the Thomson-Houston Electric Company, for many years past the clutch has been attached only to the feed-regulating lever by an elastic spring, and the result of using this spring suspension or elastic connection (the properties of which I discovered as far back as 1879 or 1880) was that the feeding action by clutches was greatly improved, not, however, because the spring served to damp vibrations, though it undoubtedly did so act, but because it secured an action of the clutch which was equivalent to an automatic slip instead of a free release. In this connection I may mention that I have built and used very many forms of arc lamps of both the clutch and clockwork types.

I have frequently operated clockwork lamps of Mr. Wood's construction on Thomson-Houston arc machines, and clutch lamps on machines of the Gramme type, and have, moreover, frequently run mixed circuits of lamps with several types of lamps in the same circuit on either type of machine indiscriminately. The lamps, so far as could be determined by an inspection of the arcs, worked very satisfactorily, and in no way different from their normal behavior. I doubt not that there are arc plants in operation in which machines of different makes and types are found mixed on the same circuit; and while this may not be very desirable always, still there is no reason why the results obtained should not be satisfactory if the types of apparatus are good, well made and properly taken care of.

While I think it possible that the smaller physiological effect of high-period alternating currents may be due to some difference in distribution, still the experiments of Dr. Tatum do not give any indication of such a result, though he sought for it. I cannot say that his experiments were perfectly conclusive on this point. From the fact, however, that the sensory nerves are to be found on the exterior of the animal body in the greatest abundance, and adapted to receive outside impressions, it would seem that the experiments of Dr. Tatum, which show that a greater amount of current at a high period could be tolerated voluntarily, are at least indicative of the fact that the current did not traverse the cuticle where the nerves are so sensitive. In such a comparatively poor conductive material as animal tissue it appears to me very probable that the distribution of current will be determined largely by conductivity of the layers and not by self-induction to any great extent, especially as the amount or density of the current which may in any case be supported is so very small.

I confess that my statement as to the motive of my critical remarks may have been out of place. They were elicited, however, by Mr. Tesla having on a former occasion misunderstood my motives and having acted on that misunderstanding.

Reply to Mr. Robert Shand on "Variations of Current in the Primary of Open Circuit Transformers."

BY WM. STANLEY, JR.

The point in question is one discussed by Mr. Shand in THE ELECTRICAL WORLD of March 21, 1891, as to the accuracy of a statement forming part of my letter to the *Electrical Engineer* of Dec. 10, 1890. In order to clearly state the facts under discussion, I quote the point mentioned: "In these transformers (open magnetic circuit) the value of the primary current varies comparatively little with the load derived from the secondary circuit, and when such a transformer is gradually loaded, the primary current will remain, roughly speaking, constant, possibly varying 10 to 20 per cent." Mr. Shand questions the accuracy of this statement, furnishing figures from tests made by himself to substantiate his position. Neglecting other results, his conclusion, as shown by Table 5 of his article in THE ELECTRICAL WORLD of March 21, gives the following data:

Size of transformer	1,550 watts.
Frequency	not given.
No. turns in primary	" "
" " " secondary	" "
Resistance of coils	" "
Size of primary and secondary wires	" "

Primary E. M. F., 100 volts; primary current, 3.27 ampères; secondary open. Primary E. M. F., 100 volts; primary current, 16.3 ampères; full load. Drop of secondary potential below normal, 3.5 volts or 3.5 per cent.

In short, in a transformer of 1,550 watts output with a 3.5 per cent. drop, the variation of primary current was from 16.3 ampères at full load to 3.27 ampères at no load: that is to say, the current fell to one-fifth of its full load value when the transformer was not doing useful work. This would certainly seem to conflict with my statement, that the variation was but 20 per cent. But how about the regulation? Certainly no station can use a transformer of 1,500 watts capacity having a drop of 3.5 per cent. Suppose that this transformer was compelled to regulate as well as others of standard make, the permissible drop would then be 1.5 per cent. What then would be the leakage current at a frequency of 130 periods per second? The resistance of the coils would evidently have to be decreased in the ratio of 3.5 to 1.5, or would be about 43 per cent. of the present value. Maintaining the same size of wire as used in Mr. Shand's experiment would give 43 per cent. of the turns, and with this number of turns the leakage current would be about $\left(\frac{100^2}{43^2} = 5\right)$ five times as great as he found it—viz., 17.5 ampères. So that if the same fall of potential upon the secondary circuit were allowed for the open as for the closed type of transformer, the current upon the primary circuit when the secondary was open would be as great as when the transformer was doing its full duty.

Of course this reduction of the drop of the transformer cannot be accomplished by simply taking off wire as indicated; the magnetization of the core given at 6,300 per centimetre gives a hysteresis loss of about 2.75 watts per pound at a frequency of 133 periods per second. The core is already magnetized too high; reducing the turns to 43 would raise the magnetization to 14,600 per centimetre, and would give an enormous loss by hysteresis, while the permeability of the core would fall so as to reduce the magnetization. In short, the transformer made by Mr. Shand cannot be compared with the commercial apparatus; it must be redesigned for 1.5 per cent drop.

In order to compare two types of transformers, it is necessary that they should be designed for the same output; should have the same fall of potential or drop, and the radiating surface per watt lost in the transformer should be the same; they should be subjected to E. M. Fs. of the same frequency, and then the comparison should be made upon the basis of efficiency and leakage current.

Since writing the reply to Mr. Swinburne's letter, to which Mr. Shand takes exception, I am in receipt of a letter from Swinburne & Co. stating that they can make a hedgehog transformer of 2,000 watts output having a drop of 2.4 per cent. which will reduce the primary current to about 40 per cent. full load value when the load is taken off. Such a transformer does not regulate sufficiently well for one of 40 light capacity, as it has about one per cent. more drop than found in all standard closed circuit transformers of the same size now in use in this country.

Rapid Transit in New York.

As we go to press there comes to us an unofficial report of the decision of the Rapid Transit Commissioners as to the steps that may be taken to relieve the metropolis from its present serious difficulties. The plan contemplated includes three distinct measures for relief. First, the existing elevated roads are to be extended to the Boulevard, and given a loop at Battery Park; second, the New York Central & Hudson River Railroad Company will be allowed to extend its rapid transit lines to the Battery from Forty-second street, not, however, touching Broadway; third, the Greathead system is proposed as a final solution of the difficulty. We sincerely hope that this report is unauthentic. We need rapid transit badly enough, but not badly enough to place the city at the mercy of the elevated roads and New York Central & Hudson River Railroad for an indefinite term of years. The elevated roads have over and over again demonstrated their inefficiency, have shown the most reckless disregard of public comfort and private rights, and the extension of them would give no advantage to compensate for the sacrifice. A tunnel from Forty-second street to the Battery will take nearly as long to complete as the proposed Greathead tunnel, and if locomotives are permitted in it will be a pest hole for the unfortunate passengers, and a nuisance to the streets above. This is no time for temporizing. If the New York Central must force its way to the Battery at all hazards, compel it to abandon locomotives and use motors through the lower part of the city, and do not inflict the smoke-befouled atmosphere of the London underground roads on a public that has already endured too much in the unlighted, unventilated and dangerous tunnel above Forty-second street. The only solution of the rapid transit difficulty is an extensive tunnel system, either on the Greathead or some other similar plan. Any less comprehensive and complete measure is not even a palliative; it is only rendering the situation more intolerable by entailing indefinite delay. More than this we need not say. We can only hope that the rumor of such an unsatisfactory and suspicious decision has no basis in fact.

Electrical Equipment of McVicker's Theatre, Chicago.

McVicker's Theatre, of Chicago, which was destroyed by fire last fall, has been completely rebuilt, and was opened to the public for the first time Monday evening, March 30. While being one of Chicago's most beautiful theatres, it enjoys the distinction of having what is perhaps the most complete electrical equipment of any theatre in this country. The entire contract for the electrical work was awarded to the Chicago Edison Company, and the switchboard and the general arrangement of the plant were designed by the company's engineer, Mr. L. A. Ferguson.

The auditorium proper is wired on the three-wire system, the stage being arranged for a 220-volt multiple series system. The switchboard is so arranged that the lamps may be fed from the Edison central station or from the dynamos in the theatre building. In the case of an emergency a single-throw switch of 500-ampère capacity transfers the load from one source to the other. The day circuit for the theatre is independently operated from a small dynamo in the basement, but is so arranged that in case it is necessary current can be supplied from the central station. The footlights and border lights have three rows of lamps, red, green and white, each color being controlled by separate switches and rheostats.

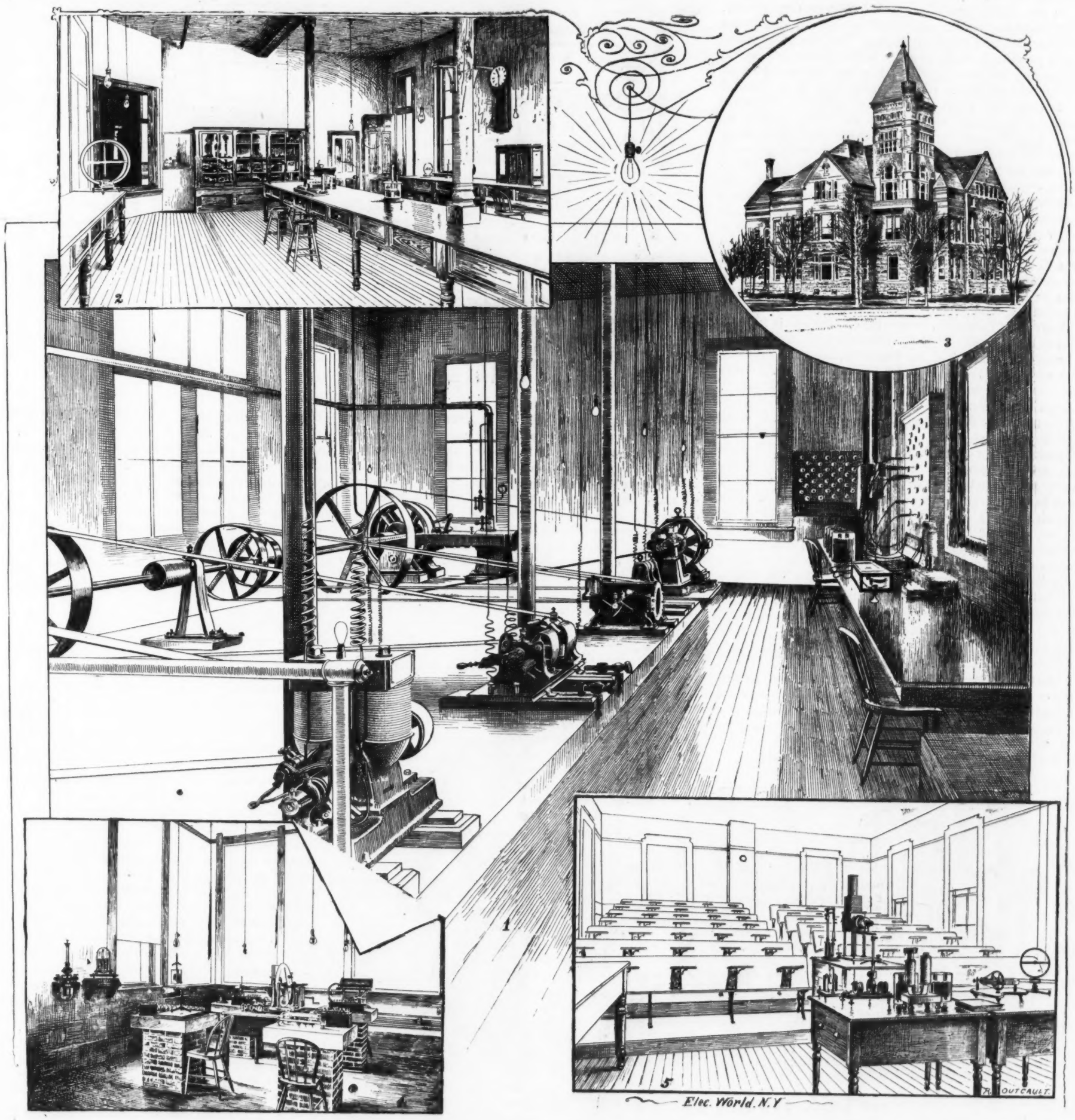
The Course in Electrical Engineering at Purdue University.

As the academic year nears its close it is well worth while to give some account of the courses in practical electricity given at various institutions of learning. Last season we described in detail some prominent schools where electrical engineering is taught, and in again resuming the series we have selected for our first description what may be regarded as a typical technical school course, as developed in Purdue University, the State Institute of Technology of Indiana. The institution started, like Cornell University, as a land grant college, but, less fortunate than the latter institution, received comparatively little outside assistance until about two years ago the State generously came to its aid and granted a permanent appropriation. At the same time there was an additional special grant made for the purpose of establishing a course in electrical engineering. During the academic year of 1888–89 the course was in process of formation, and with the completion of the new building, the succeeding year, it assumed nearly its present form.

The electrical laboratory, see Fig. 3, is a splendid two-story structure of brick and stone, with a tower and ample rooms in the roof. The lower floor is given up almost entirely to electrical work. The second story contains the physical lecture room, offices, drafting rooms and the like. The institution had a comparatively small electrical equipment at the start, but as soon as the new building was under way extensive importations were made, so that there are now available a rather full set of the best modern testing instruments, and a well-appointed dynamo room with all the paraphernalia of commercial measurement.

The main part of the electrical building contains a general laboratory, Fig. 2, a lecture room, two laboratories for special work in electrical testing, a small laboratory for magnetic and other extremely delicate measurements, a battery room and a directors' office. The dynamo room is in an accessible and well-lighted extension, as far as possible from the laboratories where delicate instruments are in use. This dynamo room is 27 × 42 feet, and is supplied with a half dozen typical modern dynamos of small size, conveniently arranged for experimentation. Power is furnished by a 22 h. p. Straight-line engine. This is placed at the extreme end of the dynamo room farthest from the main building, and is coupled directly to a line shaft running nearly the length of the room, and is supported at short intervals by substantial piers. This shaft is very carefully lined up, and carries the driving pulleys for the various machines. A glance at Fig. 1, the dynamo room, will show the general arrangement.

The equipment of dynamos consists of one of the original workshop type of Gramme machines, brought to this country at the time of the Centennial Exhibition at Philadelphia; a Thomson-Houston three-light arc machine, a Brush four-light arc machine, an Edison 40-light incandescent machine, to which supplementary series coils for compounding have been added, and a Slattery alternator specially designed for experimental work and giving an output of about 10,000 watts. In addition, a compound-wound incandescent machine is under construction from designs by the director of the laboratory. This last is a Manchester type machine, with field magnets seated on a gun-metal base. In connection with the alternating dynamo there are converters of Westinghouse, Slattery and National make. A bank of lamps and a Julien storage battery of 25 or 30 cells are also located in the dynamo room. A Sprague constant-potential motor and a Baxter constant-current motor serve as types of those classes of machines. The testing rooms, one of which is shown in Fig, 4, are fitted with substantial masonry piers independent of the flooring or foundations of the building, and are quite free from vibration. The set of testing apparatus was designed to give opportunities for the absolute measurement of resistances, and of both alternating and direct currents at all potentials. To this end the equipment includes a well-selected series of standard resistances, two of Sir William Thomson's balance dynamometers and a Weber and a Siemens dynamometer, and two Thomson electrostatic voltmeters, aside from the ordinary apparatus of testing and commercial measurement. The physical lecture room, Fig. 5, is located over the dynamo room, so that any kind or quantity of current and direct mechanical power are both easily available.



ELECTRICAL ENGINEERING LABORATORIES AT PURDUE UNIVERSITY, LAFAYETTE, INDIANA.

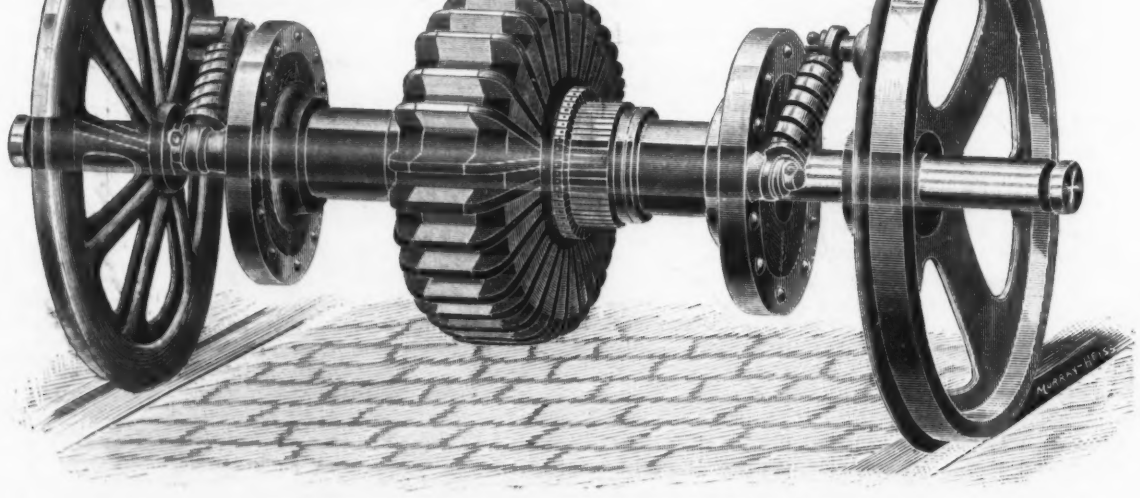
The course in the school of electrical engineering was, as a matter of necessity, developed from an unusually full course of mechanical engineering. During the freshman year the two courses are identical, covering the ordinary English and mathematical branches, free-hand mechanical drawing, work in wood and metals, pattern making and the like. During the sophomore year the courses are nearly identical, including regular work in physics, mechanical drawing, further workshop experience, theory of machine work, descriptive and analytical geometry. The school of electrical engineering differs from the other only in a half year's required work in a modern language, at present French.

In the junior year the courses diverge considerably. They have in common mathematics, chemistry, theory of mechanism, and thermodynamics. The electrical course gives practically eight hours a week instruction in the theory of electricity, magnetism and laboratory work throughout the year. In the senior year the mechanical and electrical courses have in common analytical mechanics, strength of materials, the steam engine, and some English branches; while in the electrical course there are three lectures and five laboratory exercises per week through the year on various topics in theoretical and applied electricity, including the theory of dynamos, both alternating and direct current; principles of electrical designing, electrical transmission of energy, and whatever other work may seem desirable for the thesis required of each student at the completion of his course. The course is well calculated to give the student a very practical idea of electricity, and as thorough theoretical instruction as can be crowded into a course that is necessarily contracted.

The city of Lafayette, where the institution is located, has an electric railroad and two electric light stations that, through the courtesy of the managers, are often available for additional instruction and illustration. Besides the regular routine work of instruction in applied electricity, some time is given to research work by the advanced students under the direction of Prof. A. P. Carman, who has charge of the electrical course. During the present year considerable work of this kind has been done, and some interesting experiments on transformers have recently been made, and year by year a large amount of time will be given to such investigation. The course has been growing rapidly since its inception, and each class furnishes a larger contingent than the preceding for the school of electric engineering. Altogether the course is a very creditable one for a technical school of rather recent establishment and necessary limitations from the serious difficulty that exists in obtaining students who have had the proper preliminary training.

The Short Gearless Railway Motor.

The illustration on this page shows the method of mounting of the Short gearless street railway motor recently brought out by the Short Electric Railway Company of Cleveland, O. The armature, which is intended to run at



THE SHORT GEARLESS STREET RAILWAY MOTOR.

from 100 to 150 revolutions per minute, is mounted upon a hollow shaft through which passes the car axle, as shown in the illustration. This hollow shaft is made of steel, and is about six inches in diameter on the outside, with an opening inside of nearly five inches, so that there is a clearance between the axle of the car and the inside of this hollow shaft of an inch air space all around. In the centre of this shaft the armature and the commutator are fastened, and on each end of the armature shaft are keyed two heavy crank discs made with an iron hub and rim, and a wooden web similar to the gears which have heretofore been used by the Short company. This thoroughly insulates the armature shaft from the rim of the crank wheel. This crank wheel rim has upon one side a crank pin, as will be seen in the illustration. The car wheel has a crank pin also, and between the two is stretched a heavy coil spring, capable of pulling with a very slight elongation 2,500 or 3,000 pounds. The power of the motor in turning the wheel is transmitted through these springs, and the wheel is readily turned in the direction in which the armature tends to rotate. Just inside of the crank discs are the bearings of the hollow armature shaft in the motor frame.

This motor frame is made of two castings of steel with arms projecting forward and backward. These arms rest on rubber cushions placed on channel bars which go from side to side of the motor frame. In this way the armature is held up in the frame and away from the axle, and the entire weight of the motor is supported by these spring cushions and by the car boxes outside of the wheels at the points where the car body is supported. None of the weight of the motor falls on the axle inside of the wheels. The spring cushions upon which the motor frame rests are limited in their movements to a fixed distance so that the inside of the armature shaft cannot come down upon the axle. By these means the motor is carried entirely on springs.

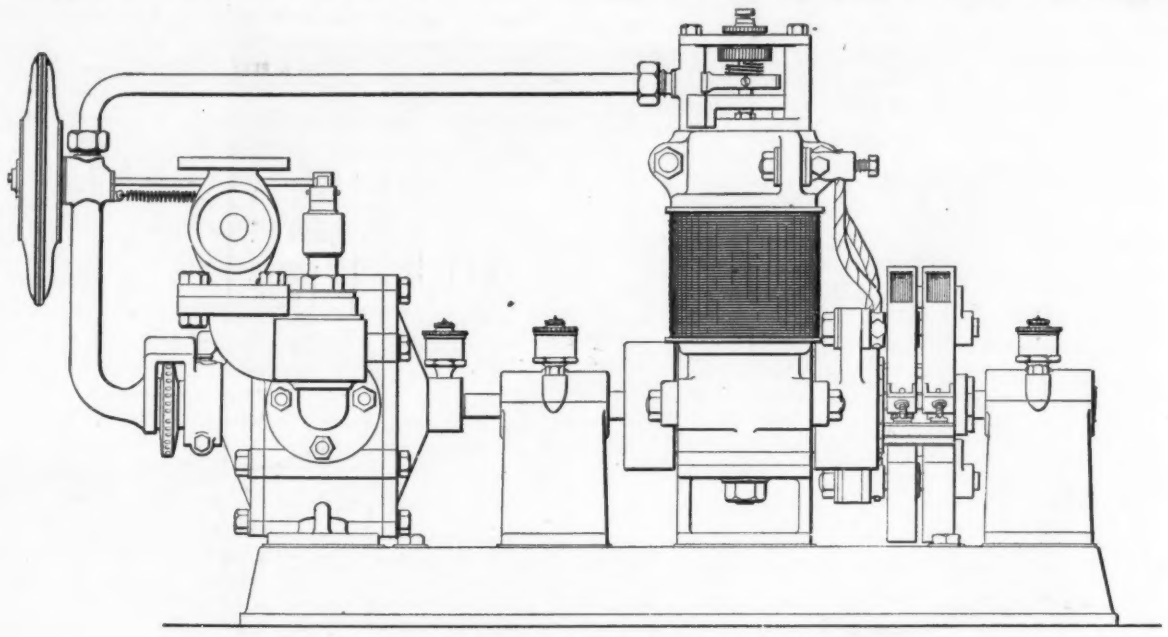
A sheet iron casing one-fourth inch thick covers the entire motor. This casing is so hung on hinges that it can be swung open to allow examination of the motor from beneath. The motor is constructed entirely of iron and steel, and its weight is about the same as that of the standard type of Short motor, and its efficiency, as might be expected, is somewhat greater.

The Dow Turbine Operating a Dynamo.

We illustrate this week an interesting application of the remarkable Dow steam turbine recently described in our columns. The combination as shown in our cut is in regular service in the United States Torpedo Station at Newport, R. I. About two years ago a Parsons turbo-electric generator was procured for use at the station, and a large number of experiments were made with it. Recently the Parsons turbine was removed and the Dow turbine put in its place, retaining the old dynamo and governor. The machine has a capacity of about 150 lights and is intended for a normal speed of nine to ten thousand revolutions per minute, a figure very easily reached by the Dow motor. As will be seen at a glance, the combined plant is rendered much more compact by the use of the present motor, which is of the regular type used for spinning the fly-wheel of the Howell torpedo, and consequently possesses a large excess of power. The governor is very accurate, and is operated through exactly the same apparatus as originally.

A word of explanation may be of interest. A small rotary air pump furnishes compressed air to the double, flexible diaphragm shown at the extreme left of the cut; a rod operated by this works the throttle valve of the motor. A check valve in the air tube is controlled automatically by a movable armature, actuated by the field magnets of the machine. The air pump, as a matter of fact, is a suction pump, and the diaphragm is distended by a spring. The result is that when any variation in the electromotive force occurs the armature closes the air escape pipe, the air pump exhausts the bellows, and the steam is cut off until the speed falls to the proper amount.

The Dow motor in this particular service has made a decided success. Its mechanical properties and great compactness render it particularly well adapted for combination with a dynamo. As it is made entirely by lathe work, the working parts can be fitted with an accuracy that is unique in steam motors. Experiments are in progress with a view of arranging larger combined plants operated by the same motor, designed, however, for a somewhat lower speed. It probably would be quite as successful to design a high speed dynamo to fit a motor as a low speed motor to fit our present form of dynamo.



THE DOW TURBINE OPERATING A DYNAMO.

The Striking Distance of Alternating Electromotive Forces.

BY ROBERT SHAND.

In commenting upon an article contributed by the writer and published in THE ELECTRICAL WORLD of Feb. 14, describing some experiments on the striking distance of alternating electromotive forces which were carried out at the laboratory of Prof. Elihu Thomson, *The Electrician*, of London, refers to the importance (as pointed out by De La Rue) attaching to the form of the discharge points, as affecting the length of the sparks produced and also to the need of more information regarding the form of the points used in the experiments described, etc.

In the published description of the experiments it was stated that "the points were as sharp as the means at command rendered it possible to make them." I may add here that they were conical in shape, having a diameter at the base of .075 of an inch, and a height from base to point of .5 of an inch. They were first shaped in the lathe, and while still kept slowly rotating were rubbed vertically on a fine whetstone until the sides of the cones were perfectly straight and smooth and the points sharp. The points thus formed were sharper than ordinary needle points, and to keep them so—to prevent deformation when bringing them together—a little cushion of soft lead was slipped between them, the thickness of which was, of course, considered when computing the distance separating the points.

With regard to the importance attaching to the shape of the points I entirely agree with the comments of *The Electrician*. The curves shown clearly indicate the importance of this consideration. It is well to emphasize its importance, however, because the various statements which one finds on the subject indicate that its importance is not sufficiently recognized. Thus the writer of an excellent paper recently published in one of our technical journals states, quite briefly, that "to produce a spark one inch in length required a potential of about 100,000 volts." This may undoubtedly be true when particular forms of discharge surfaces are employed. If very sharp points are used, probably less than one-fifth of the potential stated would suffice. When points become blunted—become more or less hemispherical in shape—the spark becomes shorter, and a curve showing maximum values of the ratios less irregular than is the case with very sharp points. When blunt points are used, curves showing maximum and minimum results approximate each other closely; with very sharp points, however, the discharges are erratic.

One result obtained while making the experiments described (discharge between point and sphere at about 700 volts) subsequent attempts failed to reproduce. It would certainly appear in this case that an unusual combination

of favorable conditions conspired to precipitate the discharge. The object of the experiments, however, was to find the maximum striking distance, consequently the greatest spark lengths observed are those shown in the curves. I would here point out that when data of this kind are wanted for application under working conditions the thing which it is generally required shall be known is not the average spark length but the greatest spark length which the electromotive force used may be expected, under the most favorable conditions, to produce.

Concerning disruptive discharges, Mr. J. E. H. Gordon aptly quotes Prof. Clerk Maxwell, who has compared such experiments to the splitting of a piece of wood by a wedge.

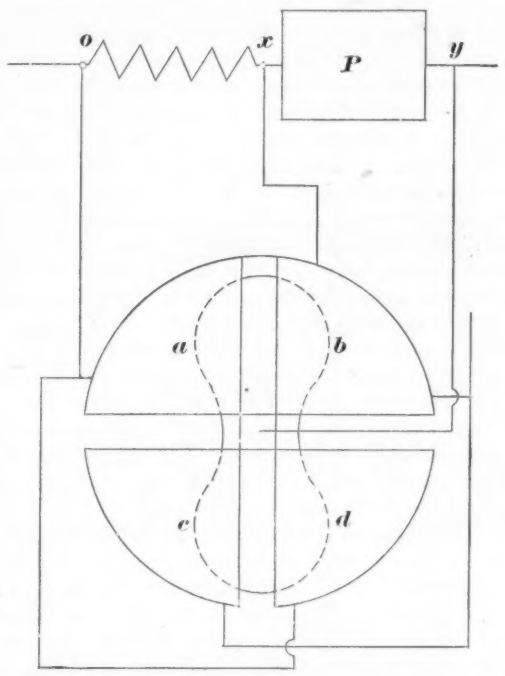


FIG. 1.—ELECTROMETER ARRANGED TO MEASURE WATTS WITH TWO READINGS.

The possibility is stated of determining the average force necessary to split the wood, also the impossibility of saying how closely the force required in any particular experiment will approximate that average. If we think of the wedge as represented by the axe of the wood chopper, it becomes obvious how much the force of the blows necessary to split the wood depends upon the more or less perfect condition of the edge of the axe. Every one who is at all familiar with the experiment of splitting thick glass plates with Ruhmkorff coil discharges, and the precautions which are to be taken to concentrate the potential to what is virtually a point on each side of the dielectric layer, will readily understand that the analogy of the wedge is by no means a far fetched comparison.

The subject of disruptive discharge is so seldom discussed without some allusion (generally speculative in its

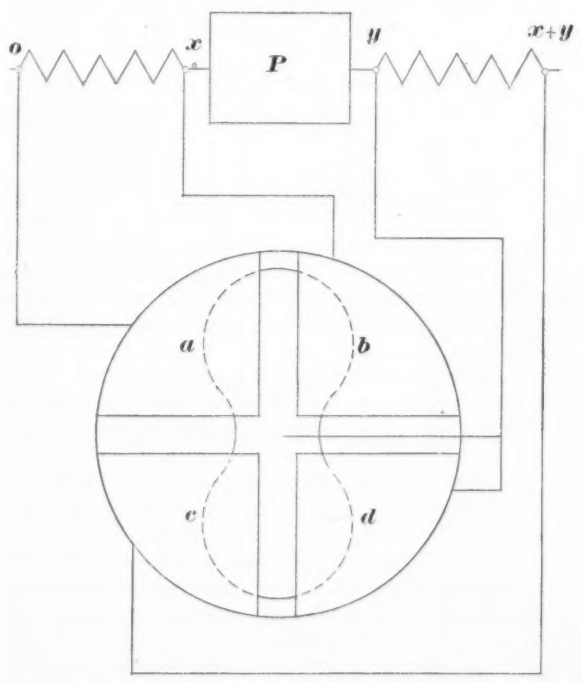


FIG. 2.—ELECTROMETER ARRANGED TO READ POWER DIRECTLY.

nature) being made to the discharges occurring in the great laboratory of nature, that the writer is tempted to be orthodox and in order to attest the same will here introduce an idea which he has heard expressed by Prof. Elihu Thomson to the effect that the phenomenal values of potential, which have sometimes been spoken of as producing lightning discharges, may be more fanciful than real. May not a potential only sufficient to break down a first layer of the dielectric act as a sort of electric wedge, capable of opening a path for itself, as it were, through many hundreds of feet?

Suppose, for example, a highly electrified cloud to be passing in the atmosphere over some prominent object situated on the earth's surface, and that the attractions of the electricities of the earth and of the oppositely charged cloud causes a depression of a part of the surface of the latter, at a point situated over such prominence. We have then a set of conditions analogous to those obtaining in the experiment, before referred to, of splitting the glass plates. If now some rain drops fall may not they assist in making up the wedge, which, entering the dielectric, begins to make the path for the discharge to pass.

It has been observed that during a storm the most brilliant discharges are usually seen amid the densest rain, and that frequently an unusual flurry of rain drops immediately succeeds the discharge, as though the charge remained upon the cloud until the falling drops brought it within striking distance, when it flashed to earth, the rain drops which had first assisted it arriving later.

If the charged rain drops do assist the cloud's discharge—and such an assumption does not seem unreasonable—it becomes quite thinkable that a true discharge between earth and clouds may be effected by a potential moderate indeed compared with the millions of volts often spoken of as necessary to effect a discharge.

Note on Electrostatic Wattmeters.

At a recent meeting of the Physical Society, of London, Mr. James Swinburne read a paper on the above subject, of which an abstract is given in *The Electrician*:

"After referring to the history of the electrometer method of measuring power developed by alternating currents, the author pointed out that the necessity for taking two readings from which to determine the watts might be obviated by having the quadrants separate instead of connected in pairs, as in the ordinary method. When Joubert published his tests of a Siemens dynamo, Profs. Fitzgerald and Ayrton simultaneously suggested the use of an electrometer as wattmeter. Non-inductive resistances are connected to the transformer, motor or other apparatus in which the power is to be measured, so as to be in series with the apparatus, and on opposite sides of it, and the four ends of these two resistances are

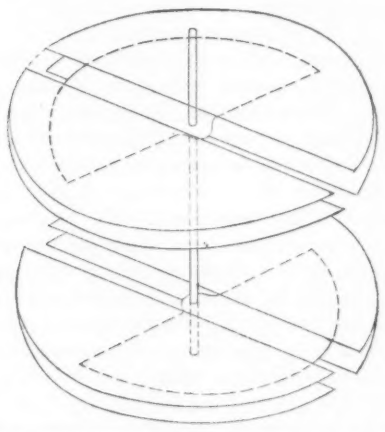


FIG. 3.—ELECTROMETER WITH SEMICIRCULAR "NEEDLES" FOR MEASURING WATTS.

connected with the four quadrants. Under these circumstances the deflection of the needle is a measure of the watts. The disposition is shown in Fig. 1. A non-inductive resistance, $o\,x$, is in series with the part of the circuit to be measured, and the quadrants, a, b, c, d, are in shunt to it, so that their potentials are o and x. The needle is connected to the other side of the circuit to be tested, and is at potential y. If the fall of potential over the resistance is small, the instrument is not sensitive—if large, it is not accurate. Prof. Ayrton has therefore introduced an accurate method depending on two readings. By using two equal resistances the quadrant electrometer may be arranged to read power directly. This is shown in Fig. 2. The quadrants, a, b, c, d, are at the potentials o, x and y and $x + y$, respectively. As this arrangement involves an end or a side pull on the needle, another arrangement, shown in Fig. 3, is better for commercial work. To increase the maximum deflection obtainable so as to make an instrument capable of being read by a pointer, the needle is made in two halves, fixed one below the other on the same stem, and, instead of quadrants, semicircular boxes are employed. The needle consists of two half discs, each between pairs of fixed half discs. A metal torsion suspension may then be used, and the needle may have a mirror or index. It can be made to read direct, through an arc of 120° or so. The electromagnetic wattmeter is the most suitable instrument for measuring low-pressure powers, but it needs many spare coils to give it a large range. For high-pressure work, such as measuring power lost in condensers, the electrometer is more convenient."

The Kingdon Inductor Dynamo.

The illustrations given on this page represent the 70-unit alternating current dynamos designed by J. A. Kingdon and constructed by Messrs. Woodhouse & Rawson, of London. In this machine, as described by *Industries*, from which our cuts are reproduced, the coils, which correspond both to the armature coils and the field-magnet coils of an ordinary alternating current dynamo, are fixed, while the revolving wheel carries a number of laminated masses of iron or inductors, which produce by their motion magnetic changes in the iron cores of the armature or secondary coils. The magnets of the dynamo are built up of a number of stamped iron plates, each plate having four projecting iron core pieces. These plates are bolted between two stout cast-iron frames, which also carry the pedestals.

The machine is divided horizontally along the centre lines, so that the top can be lifted off and the wheel taken out. There are 32 magnet cores projecting from the magnet ring, and 16 of these are fitted with the primary or exciting coils, and 16 with the secondary coils in which the alternating current is generated, primary and secondary coils being placed alternately. In the diagram (Fig. 1) the poles marked *N S N S* are primary poles, and are magnetized by means of an exciter with the polarities indicated. The intermediate poles, *n s n s*, are the secondary poles, and have their magnetism constantly changed as the inductor wheel rotates. The number of inductors, which consist of a number of stamped iron plates bolted

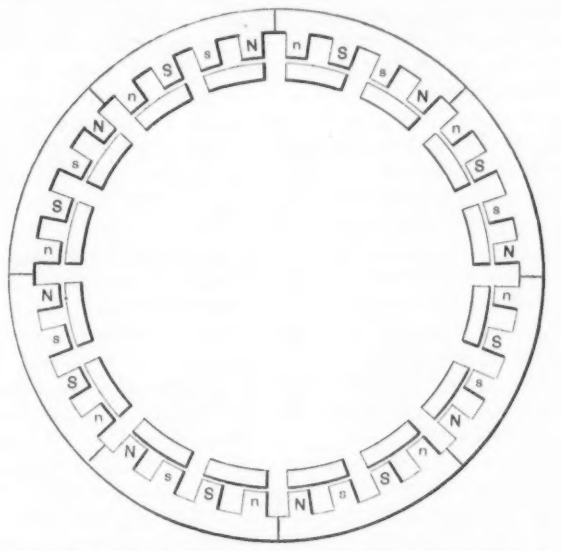


FIG. 1.—DIAGRAM SHOWING ARRANGEMENT OF POLES.

between two steel discs carried on a hub on the shaft, is 16, being equal to half the number of the magnet cores.

The action of the machine is as follows: In the position of the wheel shown in Fig. 2 the secondary poles have the polarities indicated, being magnetized by the primary poles with which they are connected through the inductors. When the inductor wheel has rotated through the one-thirty-second of a complete revolution, the secondary poles will all have their polarities changed, being now magnetically connected through the inductors, each with the primary magnet on the other side. The inductor wheel thus acts as a magnetic commutator, and, as it rotates, continually changes the polarities of the secondary magnets. Alternating currents are accordingly generated in the coils wound on the secondary magnets. The polarity of the secondary magnets being changed 32 times each complete revolution, the number of alternations per revolution is 32, being equal to twice the number of the inductors, and being quite independent of the number of primary or secondary coils.

The dynamos of this type at the Woking central station are coupled direct to triple-expansion engines running at about 260 revolutions per minute. The periodicity of the

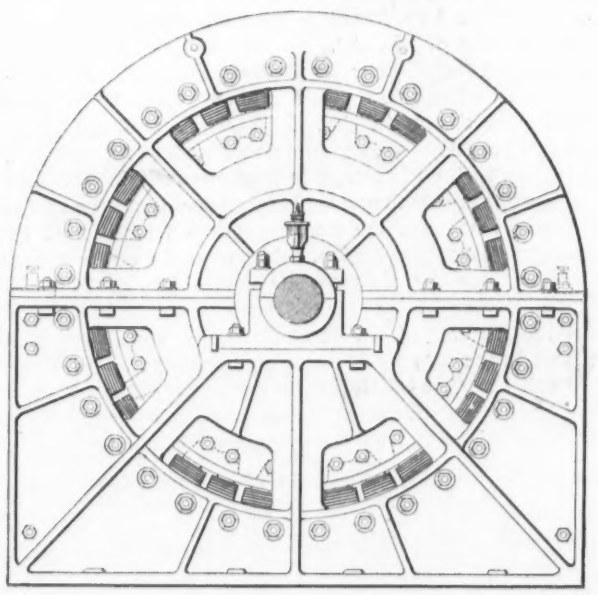


FIG. 2.—THE KINGDON INDUCTOR DYNAMO.

machines is therefore 70. Each machine is divided into halves, each half giving 15 ampères at 2,000 volts at the speed mentioned. Either the top half or the bottom half can be used alone, or the two halves may be used together as one machine. When the load on a machine is less than 30,000 watts, one-half only of the primary magnets are excited, and current is taken from the corresponding secondaries. The principal dimensions of the machine are: Length, 6 feet 8 inches: height, 6 feet 8 inches; width, 3 feet 9 inches. The inductor wheel is 4 feet 6 inches in diameter. The inductors measure 12 inches by 8 inches on the face. The magnets are 3 inches long, and measure 12 inches by 3 inches on the face. The resistance of eight primary coils connected in series is 2.8 ohms, and of eight secondary coils 1.8. The total weight of the machines is about 7½ tons.

The Magnetic Circuit of Transformers: Closed Versus Open.*

BY S. EVERSHED.

(27) Leaving the discussion of this question until we have explained the method of drawing transformer indicator diagrams, we will now describe the ingenious device adopted by Mr. Swinburne for reducing the exciting current in an open transformer to more reasonable, or, let us say, less unreasonable, dimensions.

Reverting for a moment to the result arrived at (by a process resembling guesswork, it must be confessed) for the value of the magnetic resistance of the air path, it is easily seen that the most obvious improvement consists in increasing the radius of the "equivalent" sphere. If we do this by putting a solid lump of laminated iron on each end of the core, we soon find we are using sufficient iron to make a closed circuit. Suppose we slip the core plates up at each end into very narrow ribbons, and spread these out radially in all directions, so that their ends lie approximately on the surface of a hemisphere. The outline of the transformer will now be something like Fig. 7; the radius of the spherical surface is, roughly, equal to the length of the slit portion of the core (that is to say, to the length of the core projecting outside the coil), plus the average distance from the axis of the core to its surface. In estimating the surface of the equivalent sphere we are met with a new difficulty, namely, that the ends of the ribbons not forming a continuous surface, it is impossible to say exactly what their effective surface really is. We shall probably err on the safe side if we count the hemispherical surface formed by the ribbon ends as being continuous, and leave the flat surface of each hemisphere next the coil cheeks entirely out of account. It is as well to mention here that, although this apparently loose and utterly unjustifiable reasoning was used by the writer in the absence of any experimental evidence of its even approximate accuracy, yet the actual exciting current required by "hedgehog" transformers agrees very closely with that calculated on such a slender basis of fact. The radius of the hemisphere of ribbon ends (Fig. 7) is about 13 centimetres, so that its surface is 106 square centimetres, and the radius of the "equivalent" sphere will be 9.2 centimetres, as against 5 centimetres in No. O.1, so that H spent on the air path will be reduced in the ratio $\frac{5}{9}$, and becomes 7,200, to which H required for the core, viz., 500 roughly, must be added, making the total 7,700, as compared with 13,400 for No. O.1. The exciting current will, of course, be reduced in the same proportion, and will now be 1.95 ampères. This is better, and leads to a higher all-day efficiency, as will be seen from table XII.:

TABLE XII.—TEN HORSE-POWER OPEN TRANSFORMER (No. O.3).
Maximum $\mathsf{B} = 10{,}000$; $F = 70$ (hedgehog ends).
Load as in Table V.

Total output	24,000	watt hours.
24 hours' waste in core at 137	3,280	"
24 hours' waste $Cp^2\ Rp$ at (7.5×1.95^2)	700	"
6 hours' waste $Cp^2\ Rp \times Cs^2\ Rs$ at 62	372	"
	28,352	

Efficiency $\frac{24}{28.4} = 85$ per cent.

Full load drop = 2.8 per cent.

(28) The efficiency of No. O.2 is, in fact, as high as that of the best of the three closed transformers (No. C.2), and examination of the losses in table XII. suggests that the core waste can be reduced by lowering the induction just as in the case of No. C.2. In short, if we convert C.2 into an open transformer by precisely the same modifications as we adopted in producing O.2, we get the open transformer shown in Fig. 8. The width of the plates being 10.2 centimetres, the projecting ends of the core are, of course, 20.4 centimetres; so that when slit into ribbons and spread radially they form hemispheres twice the radius of those in O.2, and the exciting current is reduced in nearly the same proportion, being actually one ampère. It will be remembered that when the original closed transformer, having 6,600 cubic centimetres of iron in its core, was modified into C.20, we were obliged to increase the volume in the core by 30 per cent. to make room for the new coils, so that C.2 had 8,580 cubic centimetres of iron in the core. Of this amount only 5,450 cubic centimetres are required for O.2, so that the core waste is reduced in the ratio $\frac{545}{848}$, and becomes 103 watts. The efficiency of O.2 is given in table XIII.

TABLE XIII.—TEN HORSE-POWER OPEN TRANSFORMER (No. O.2).
Maximum $\mathsf{B} = 5{,}000$; $F = 70$.
Load as in Table V.

Total output	24,000	watt hours.
24 hours' waste in core at 103	2,470	"
24 hours' waste $C_p^2\ R_p$ at (7.6×1^2)	182	"
6 hours' waste $C_p^2\ R_p + C_s^2\ R_s$ at 62	372	"
	27,024	

Efficiency $\frac{24}{27} = 89$ per cent.

Full load drop = 2.8 per cent.

(29) The full load efficiency of No. O.3 is very high, being just 96 per cent., so that by converting C.2 into an open transformer, we have greatly improved it in efficiency at all loads, lessened the cost of materials, and probably also cost of construction. The one disadvantage introduced is the larger exciting current.

It will be noticed that when once the bold step is taken of reverting to an open magnetic circuit, Mr. Swinburne's "hedgehog" suggests itself very naturally as an easy way of reducing the exciting current without increasing the volume of iron required for the core; only no one ever took that step.

(30) There are a few points that require notice, which we have hitherto neglected entirely in order to keep the comparison between open and closed transformers as free as possible from confusing details. In estimating the drop in volts at full load, an allowance must always be made in practice for the drop due to an independent back E. M. F. acting in the primary or secondary coil, or in both. In every practical transformer the primary or secondary coils are separately wound, and there is often a considerable space left between the coils. Each coil will then be threaded by induction due to its own current, only a portion of such induction threading both coils. The latter portion may be conveniently called "useful induction," the former being "stray induction." It is the stray induction which causes the back E. M. F. in each coil, and the quantity of stray induction being proportional to the currents in the primary and secondary coils (that is to say, proportional to the load), the back E. M. F. simply produces an extra drop in volts over the coils beyond that due to resistance. The amount of this extra drop, being dependent on the shape and position of the coils, is capable of being reduced to practically nothing; if the primary and secondary wires could with safety be wound side by side, the only stray induction will be that round and in each individual wire. Even in practice the effective stray induction may be made extremely small by a judicious arrangement of the two coils; but as we are not here concerned with transformer design, we need not discuss the matter. Any extra drop in the closed transformer we have described will be very nearly the same in all, and so does not affect the comparisons made. With the open transformers the case is rather different; the stray induction bears a far larger proportion to the useful induction, and its direction varies slightly with the induction density in the core: it may be greatly reduced, however, by suitable windings.

FIG. 7.—NO. 3 TRANSFORMER, OPEN HEDGEHOG ENDS.

(31) Another small detail in the case of open transformers has not yet been mentioned. We used exactly the same coils on the closed and open types. In practice, a few extra turns will have to be put on the secondary to keep the secondary E. M. F. at the proper value. It is readily seen that the whole induction due to the exciting current cannot be made to thread the secondary coil, so that its E. M. F. will be less than that calculated on the assumption that it is equal to the primary E. M. F. multiplied into the ratio of the turns on the two coils. As a matter of fact, the assumption is by no means necessarily true in the case of closed transformers. If the space occupied by the two coils is large compared with the area of the iron core, the secondary will require a few more turns than the calculated number. This is a point by no means generally understood by manufacturers, and the writer, by a curious accident, discovered that in the case of a well-known and largely used transformer the secondary and primary E. M. F.'s had been assumed to be proportional to the number of turns on the respective coils, with the result that the actual secondary E. M. F. was 10 per cent. below the calculated.

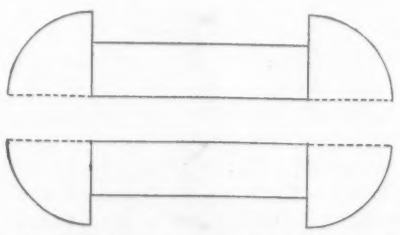


FIG. 8.—NO. 2 TRANSFORMER, OPEN HEDGEHOG ENDS.

It will be remembered that, in estimating the losses in closed circuit transformers, eddy currents losses in the coils themselves were neglected as too insignificant to have any appreciable effect. In an open transformer a considerable fraction of the useful induction, in passing from pole to pole, traverses some of the windings near each end of the core, so that coils of copper tape, which are extremely convenient and perfectly admissible in a closed transformer, would probably lead to some energy waste in an open transformer.

(32) It will be convenient to pause at this point and review the results arrived at so far in this more or less theoretical investigation. For the sake of easy reference, the chief features of the six best modifications of the original transformer are collected in table XIV.

The exciting currents are, of course, only approximate; the two last columns give the approximate weights of iron and copper used in pounds. Nos. 1 and Nos. 2, it should be remembered, are identical so far as dimensions and disposition of core and coils are concerned, and No. 1 is not therefore inserted in the table as an open transformer at a low frequency. It is easily seen that its efficiency under these conditions would be raised by four or five per cent., but it would still compare unfavorably with No. 3 and No. 2.

TABLE XIV.—SIX TEN HORSE-POWER TRANSFORMERS. FULL LOAD DROP = 2.8 PER CENT. IN EACH.

Description of transformer.	Frequency (v per sec).	Max'mum induction (gausses).	Exciting current (amperes).	Percent'ge efficiency.		Weight of materials.	
				All day.	Full load	Iron.	Copper
CLOSED.							
No. 1 low frequency	35	10,000	.22	80	94.0	143	240
No. 2 low induction	70	5,000	.11	85	95.0	143	240
No. 3 small core	70	10,000	.18	81	94.5	60	173
OPEN.							
No. 3 small core (plain ends)	70	10,000	3.4	81	94.5	37	173
No. 3 small core (hedgehog ends)	70	10,000	1.95	85	95.0	37	173
No. 2 low induction (hedgehog ends)	70	5,000	1.00	89	96.0	91	240

(33) According, then, to the results condensed in table XIV., the efficiency of any closed transformer, good, bad or indifferent, is raised (both at full load and on a time load when converted without any change in the windings into an open transformer with hedgehog ends. The increased efficiency is due to diminution in the volume of the core, and is purchased at the expense of a largely increased exciting current, the total magnetizing force for a 10 h. p. hedgehog being roughly 10 times that required by the same transformer with a closed magnetic circuit. We have just stated that these results apply to *any* transformer, and made no restriction as to size or output. It is not necessary to work out examples of larger or small transformers in order to realize that this is true in a general sense; in fact, we can predict that the larger the transformer the greater the increase in efficiency when its magnetic circuit is opened. For removal of a large part of the core must raise the efficiency, even if the C^2R loss due to the exciting current increases at the same rate in large as in small transformers; but actually the ratio of extra loss in C^2R, due to the large exciting current required by an open transformer, to the total waste becomes less and less as the transformer is increased in size, since the magnetic resistance of the air path practically depends only on the radius of the hedgehog ends, and only to a very minute extent on the distance from pole to pole. The same considerations apply with equal force (but in an opposite sense) to transformers of less than 10 horse power, so that if a two horse-power closed transformer, for example, were converted into a hedgehog, we should find the $C\ R$ loss for exciting current increased in a much larger ratio to the total waste than was the case in the 10 horse-power transformers. But a glance at tables XII. and XIII. clearly shows that this loss might be very largely increased indeed before it balanced and neutralized the saving effected by throwing away a large portion of the iron core, so that there will still be a clear gain in efficiency on converting a small closed into an open transformer, although the smaller it is the less the gain on any given time load. However, a small diminution in the total daily waste is worth having in a little transformer suitable for running a single house and therefore working for a very short time on anything like full load. A larger transformer, running a few hundred lights, would, in all probability, have one or two shops or offices in addition to houses on its secondary circuit and would feel the benefit of a more evenly distributed load.

(34) Our investigations lead to the conclusion that in order to compare the merits of two transformers it is practically useless to compare their full load efficiencies, for the worst transformer is reasonably efficient at full load; all we need do is to determine the energy losses, and of these the constant losses constitute a criterion of efficiency. This, in brief, is the contention advanced originally by Mr. Swinburne in his British Association paper, read in 1889. Indeed, many of the results independently arrived at in the present articles are stated, or rather concealed in Mr. Swinburne's paper, and may be unearthed by those possessed of more patience than the present writer. Most of the tables in the paper are valueless for purposes of ready comparison, the amount of the drop in volts at full load having apparently been left to chance.

We will now examine a little more closely the nature of the constant losses in transformers, and for this purpose it will be convenient to construct diagrams showing the phase relations and approximate forms of the curves of induction, exciting current, eddy currents and electromotive forces, when a transformer is run with its secondary circuit open.

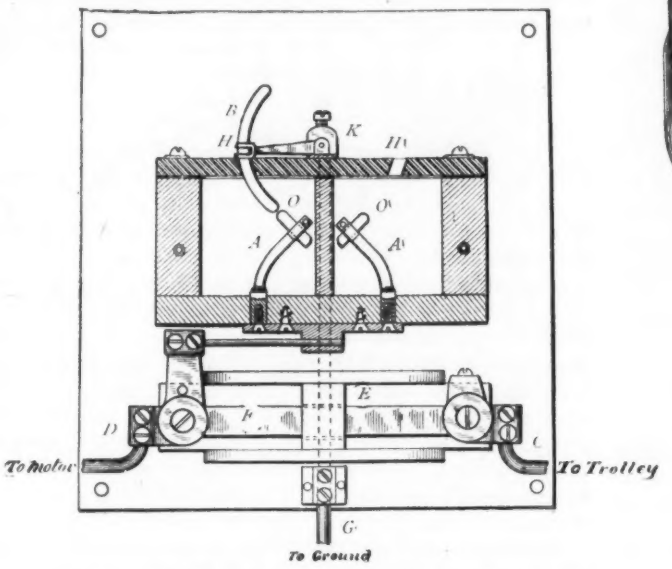
(35) Before a diagram can be drawn, it is necessary to know the form of the wave of the impressed E. M. F. at the terminals of the primary coil. In attempting to treat transformer problems analytically, it has been the invariable practice to assume that the E. M. F. wave followed a semi-soidal law. Because, according to Fourier, *any* function whatever can be expressed by an *infinite* series of sine or cosine terms, the mathematical tailors, alluded to in Paragraph 1, after an invocation addressed to the mighty powers of Fourier's theorem, calmly cut down the infinite series to one solitary term, and then find that the primary and secondary current waves (and the induction wave also sometimes) are one and all simple sine functions of the time. Such a trifle as the possible effect of hysteresis in altering the shape of the waves must give way before the powers of analysis, and the theory of transformers resolves itself into transcendental trigonometrical transformations which more or less completely mask the real phenomena involved in electrical transformation.

(To be continued.)

Continued from THE ELECTRICAL WORLD of March 28, 1891.

Westinghouse Street-Car Lightning Arrester.

The Westinghouse car lightning arrester, shown in the accompanying illustration, consists of two air chambers, A and A^1, having vents shown at H and H^1, through which the curved carbon, B, hinged at K, can freely pass, swinging from O to O^1. The carbon point O should be set so that it is separated from B when in its normal position, as shown in the figure, by one-sixteenth of an inch. The distance from O^1 to B should likewise be one-sixteenth of an inch when the curved carbon is in the other chamber. B is connected to G^1 and O and O^1 to D. F is a lead



WESTINGHOUSE CAR LIGHTNING ARRESTER.

fuse, and E an insulating block provided with a slot through which the lead fuse is passed. The points C and D should be connected in series with the motor, and G should be connected to the ground, as shown in the figure. The action of the arrester is as follows:

When a discharge takes place it passes through the lead fuse F to one of the carbons O or O^1, depending upon the position of B; then across the air space to the curved carbon B, and from there to the ground, as shown in the figure. The dynamo current then following causes an arc to be established between the carbon B and O or O^1. The heat generated by this arc expands the air in the chamber, increasing the air pressure, and causes the carbon B to be instantly blown from one chamber to the other. This ruptures the arc and adjusts the arrester for the next discharge.

In the reported tests upon this arrester, 500-volt and 1,000-volt generators have been repeatedly short-circuited through it. In every case the circuit has been instantly broken without injury to the dynamo, and the arrester has as quickly set itself in readiness for future use. In one of the tests made to demonstrate its promptness and reliability, carbons O and O^1 were so adjusted as to touch the carbon B in either of its two normal positions. A 1,000-volt generator was then short-circuited through the arrester, which resulted in the circuit being several times automatically opened and closed in one second without injury to either dynamo or arrester.

Repairs of Incandescent Lamps.

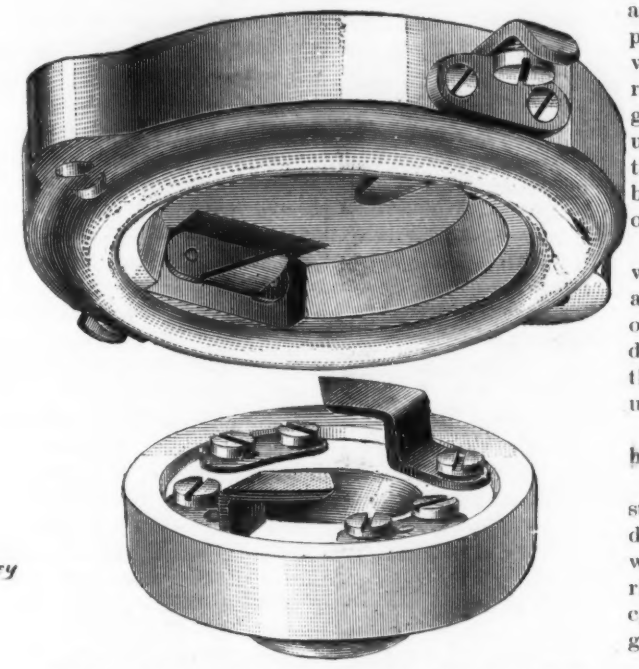
A process for the repair of incandescent lamps, as developed and put into actual practice by a French engineer, may be described as follows:

The glassblower takes the lamp and makes at the top a hole large enough to admit a new filament. The lamp thus opened is passed to a girl, who, by means of special nippers, cuts the broken filament, which she removes, being careful to leave on each platinum support about one millimetre of filament. A second girl takes the prepared lamp and places it in a socket, to which current is led; she then fills the bulb with a hydrocarbon liquid, and introduces a new filament previously standardized. By the aid of a pair of special pliers she touches the filament to one of the ends left and turns on the current. The liquid becomes decomposed into hydrogen, which rises through the liquid, and into solid carbon, which is deposited upon the joint, firmly connecting the filaments together. The same is then done for the other end of the new filament.

The next process is the cleaning of the glass bulb, which, it is stated, becomes, if anything, cleaner than the new lamps. The glassblower then takes the lamp again, attaches a tube of glass to the opening made, and the repaired lamp is then exhausted, the process of exhaustion taking three-quarters of an hour, each pump carrying five lamps. The bulb is then closed in the usual manner. The different operations described are performed very rapidly, and form an elegant and practical process, and may be repeated many times. For "Sunbeam" lamps the process is easier still, on account of the size, and may be performed either to replace filaments or to clean the bulb.

Three Styles of Cartwright Rosettes.

In the plain and ornamental patterns of the Cartwright porcelain rosette, which are put upon the market by The E. S. Greeley & Co., of this city, the brass connectors to which the wires are fastened have a slight projection from the base underneath the overhanging screwhead, opposite the point where the wire rests when it is clamped. The object of this projection is to prevent undue torsion of the screw when it is turned firmly down to clamp the wire. When there is no such support there is a tendency to damage the connection; whereas when the screwhead is equally supported on both sides, on one by the wire itself and on the other by the projection, better results are obtained.



THE CARTWRIGHT WATERPROOF CUT-OUT.

In the Cartwright waterproof cut-out, illustrated on this page, this feature in the conductor is not only present, but special stress is laid upon the fact that there are no screwholes or metallic connections of any kind leading from the inside of the cut-out that might form contact with a damp ceiling. In fact, as the name implies, it is claimed to be a waterproof cut-out. There is nothing specially novel about the manner in which the cap of this cut-out connects with the base, as several other cut-outs are made upon the same general principle; and while there is no criticism to be made upon the way in which the cap containing the fusible wire and the base interlocks automatically, the waterproof character of this cut-out cannot be too highly commended. The cuts shown are full-size.

The Woodbury Engine.

In the illustration on this page is shown the Woodbury automatic cut-off high speed steam engine manufactured by the Stearns Manufacturing Company, of Erie, Pa., especially for service in electric light and power stations. It is the invention of Mr. Daniel A. Woodbury, of Rochester, N. Y., and possesses many points of interest to builders and managers of central stations.

In the adjustable balanced valve the steam pressure is eliminated from the valve by the relief plate on the back, which is supported against steam pressure at the top and bottom by a forked or double wedge whose length is about equal to that of the relief plate. A longitudinal movement of the wedges inward will force the relief plate away from the valve, and the outward movement of the wedges will let it down toward the valve. The movement of the wedges, and consequent adjustment of the relief plate, is accomplished by the two adjusting screws, which fit loosely through the cross piece of the wedge and are tapped into the relief plate. The collars which form part of the adjusting screws are notched on their peripheries, one notch representing $\frac{1}{100}$ of a turn, moving the wedge lengthwise $\frac{1}{1000}$ of an inch, and the relief plate toward or from the valve $\frac{1}{10000}$ of an inch, corresponding to $\frac{1}{20000}$ of an inch on each face of the valve.

The valve, besides taking steam at the ends, has supplemental admission ports, which are connected at the top and bottom by passages. The admission, therefore, takes place at four points at the same time, and, as the ports are very large, the nearest approach to boiler pressure is reached, and the usual loss between boiler and cylinder greatly reduced. The initial pressure is well maintained up to the point of cut-off, even under the heaviest loads, and the cut-off takes place promptly, the closure of course being made at four points simultaneously the same as the opening.

A double exhaust is also used, the valve being provided with supplemental exhaust ports, furnishing a very large area of opening for exit of the exhaust steam, and as the opening also takes place very rapidly the pressure drops promptly at release and is maintained at or close to that of the atmosphere, even under the heaviest loads, until the exhaust ports close for compression.

The cylinder and steam chest form one casting. Both heads are made steam tight to cylinder by ground joints.

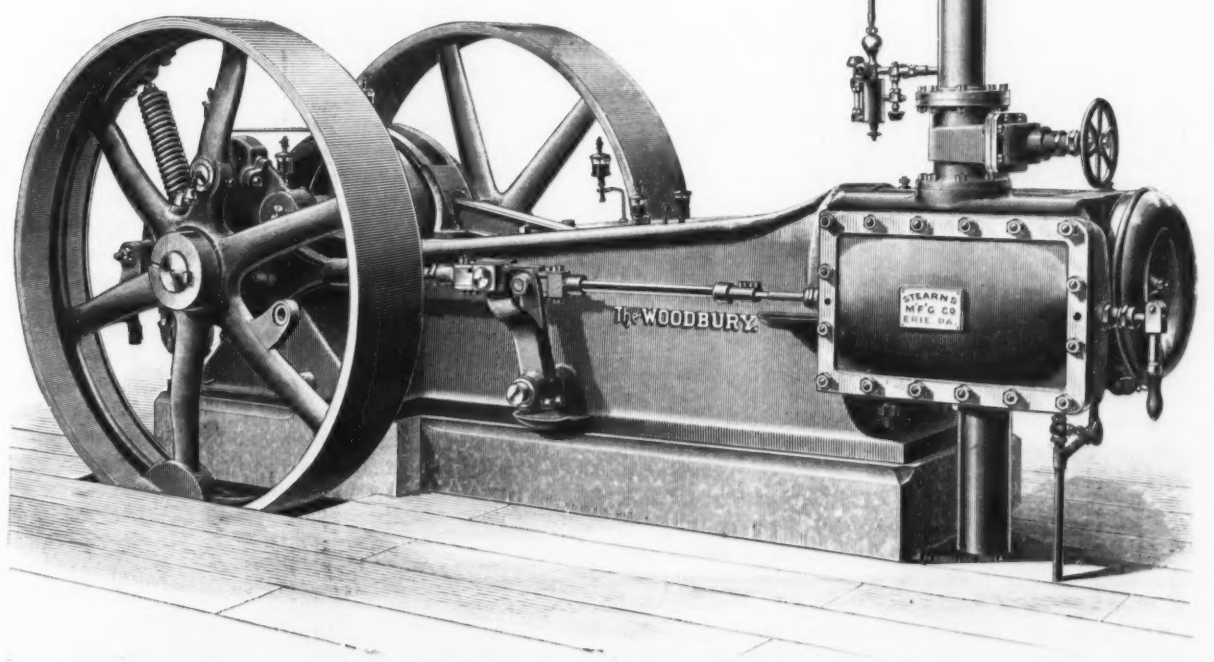
The piston is hollow and as light as the requirements of strength will permit. It is in length equal to one-half the diameter of cylinder, on all sizes, which furnishes ample wearing surface. The packing is simply narrow cast-iron rings, turned eccentrically and somewhat larger than the cylinder, and after they are cut sprung into corresponding grooves in the piston head.

The frame is of unusual depth, is heavily ribbed on the inside and has plenty of metal in it, especially at the crank end. Cavities are provided for catching the oil from the main boxes, eccentric and rocker arm.

The governor is of that class in which the point of cut-off is effected by moving the eccentric across the shaft, thereby varying the length of the valve travel. The movement of the eccentric is operated by centrifugal weights, the opposing force being furnished by a single spiral spring.

Tests of the governing power of the engine, made by Geo. H. Barrus, of Boston, show that while the variation of indicated horse power was from 12.24 to 46.05, which was 25 per cent. above the commercial rating of the engine, the speed changed from 304 to 301 revolutions, or about one per cent., and that with a change of boiler pressure from 80 to 40 pounds, the speed changed from 303 to 302 revolutions, or only about one-third of one per cent. These engines are built in sizes ranging from 18 to 160 h. p., and are run at speeds varying from 325 to 200 revolutions per minute.

In another test made at high speeds, a change of indicated horse-power from 16.41 to 63.69 produced a change of speed from 355 revolutions per minute to 350, or about 1.4 per cent. It is obvious from these comparisons that the engine, as regards regulation, is adapted to meet the most exacting requirements that can occur in the operation of dynamos for electric light and power plants.



THE WOODBURY AUTOMATIC HIGH SPEED ENGINE.

Transformer Distribution.*

BY J. SWINBURNE.

The compound form is best, because the whole station will then supply the mains at constant pressure, if all the engines are mechanically governed for constant speed of one of them—that is to say, if the whole steam supply is regulated to keep the speed of all the engines constant, the engines taking the steam in proportion to their size. Instead of keeping the speed constant, an electric governor can keep the electromotive force of the whole station constant. With alternate machines, as at present commonly used, it is necessary to alter the field excitation by hand or by automatic gear. Such machines as those described have advantages corresponding to those of compound direct current dynamos, compared with shunt or separately

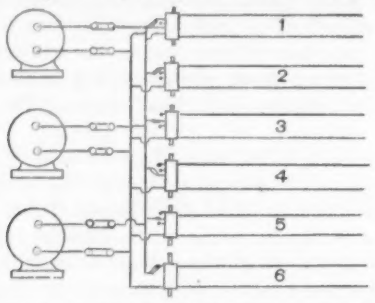


FIG. 8.—ARRANGEMENT OF STATION WITH DYNAMOS IN PARALLEL.

excited machines. The analogy between these machines and compound or shunt direct-current machines must not be used too far. In direct-current machines the electromotive force adapts itself by slight alterations of speed, and the armature reaction depends on the position of the brushes; in alternate machines the speed is unalterable and the armature reaction depends on lead and lag.

Prof. E. Thomson tells me that he has been accustomed to send out separate and series excited machines for working in parallel, and that they will work either with or without "equalizing connections" such as are needed with direct compound machines. They also work well as motors, and so do the self-exciting machines with separate exciting armature circuits. He also finds the ordinary Thomson-Houston machines work efficiently as motors.

In discussing such questions, however, we must always remember that the size of the machine is most important. A small dynamo has high resistance, small cross induction and small armature reaction. A large machine has a small resistance and great armature reaction. Large machines may therefore easily run well in parallel or as motors, without automatically varied field excitations. A very small lagging current will reduce the field of a large machine three or four per cent., and the extra loss of power in the armature is small; for if C is the component of the current that is in step, and c the lagging component, the

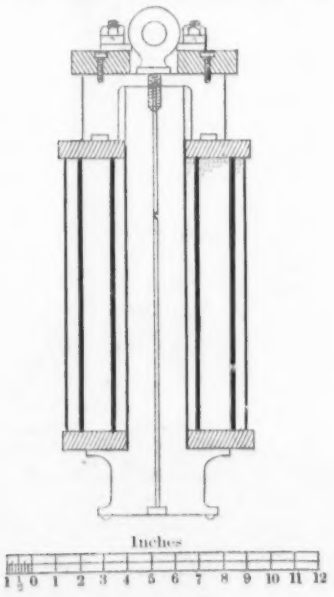


FIG. 9.—TRANSFORMER OF 50 LIGHT CAPACITY.

power wasted in the armature is not $r\,(C+c)^2$, but $r\,c^2 + r\,c^2$—a very different matter.

The case of motors, however, is not the same. A two-horse or one-horse motor is about the size that is most needed. There is no opening for 100-kilowatt motors on supply circuits just now. In these small sizes c will be very large compared with C, so automatic regulation of the field may be of the highest consequence.

The subject of motors is of enormous importance, and is most interesting. I fear it cannot be pursued here, for want of time. It is to be hoped one of my hearers may be induced to write a paper on this subject at an early date, unless, as is probable, it is exhausted in Mr. Kapp's Cantor Lectures.

According to the armature-reaction theory, then, whether a machine will run in parallel with others depends on its armature resistance and armature reactions. It must be borne in mind that most machines have cast-iron fields, and though that may make no difference according to the orthodox theory, it does from the armature reaction point of view. If the field magnets do not quickly respond to the armature reactions, it may be difficult or impossible to run machines in parallel.

Another important consideration is the government of the engines. If two engines are working two machines in parallel at 200 revolutions, and one governor is set for 200 and the other for 195 revolutions—if the governors are truly isochronous, one engine and dynamo will supply the whole of the power, and the other will be dragged round idle. The whole question of the government of central stations requires the most careful consideration. I have dealt with the matter at some length elsewhere,* but the subject should be very fully thought out in designing stations.

ARRANGEMENT OF STATION.

Whatever system of distribution be used outside the station, the power leaves by high-pressure leads. In this country 2,000 volts is the pressure commonly employed; in America 1,000. I cannot help thinking that the Americans are right. The use of 2,000 volts does not decrease the cost of copper so very much, and it increases the cost of insulation enormously. In addition to this, it increases the dangers of breakdowns and the chance of danger to life. Two thousand volts seems to have been chosen in the early days, when people had very little idea of the commercial difficulties of high-pressure insulations. In addition to this, high pressure increases the cost of transformers as well as dynamos, and also lessens the output for a given size.

If the machines are employed in parallel, they may feed into common bars, as in the case of direct currents. If each district must have its own circuit—which seems to be generally assumed necessary—each circuit may be led away from the common bars with a transformer regulator in it. One objection that has been raised against parallel working is that, if each district has its own system, it may have an earth on one lead without disaster, while, if the station is in parallel, two leaks in the whole system cause a breakdown. This objection comes from America, where they have had a great deal of experience, but it seems to

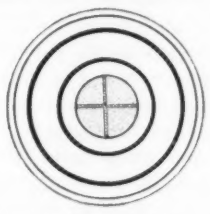


FIG. 10.—TRANSFORMER OF 50 LIGHT CAPACITY.

assume the leads to be in a very bad state. There is no need for such danger, however, for each district may be fed through a transformer, so that it has no metallic connection with the system of any other district. It is most difficult to understand why central station machines are made to give high pressures to begin with. In most forms of dynamos 2,000-volt insulation adds very materially to the cost of the machine, and lessens the output for a given size in addition. The difference of cost would more than cover the extra cost of transformers, as large converters can be made for considerably under £1 per 1,000 watts; and the efficiency, when very large, is very high, being above 99 per cent. at full load. So that the efficiency of a low-pressure dynamo and transformer is higher than that of a high-pressure dynamo working direct. It is also a great advantage to have all the switches, connections and measuring instruments on the low-pressure side. The high-pressure circuits may then be arranged to have no metal exposed anywhere. If each district must have its separate circuit, it has its own step-up transformer, with its regulator. If feeders are used on any system, each feeder has its step-up transformer, which is made adjustable; or it may have an adjustable transformer and a feeder regulator such as that designed by Mr. Kapp. If the district is large, it may have large transformers. Several feeders may then come off in parallel, each feeder having its own regulator. The regulators may have the adjustable parts connected with the low-pressure supply, so as to avoid high-pressure switches or other gear.

One arrangement is shown in Fig. 8. The dynamos are all in parallel, and wound for 100 volts, the immediate neighborhood of the station being fed direct. Each feeder circuit has a transformer with a variable number of primary turns. A compensated voltmeter is placed on each, and all the attendant has to do is to alter the switches a little occasionally, so as to keep all the instruments' pointers vertical.

TRANSFORMERS.

It is not my intention to go into the question of leads, as I am informed that a paper specially devoted to that important subject is to be read here very shortly: I am therefore most happy to leave the very special question of high-pressure alternate current mains in far abler hands.

Before discussing the relative merits of house transformers, low pressure direct from the station, and various sub-station arrangements for distribution, it will be best to consider the vexed question of the transformers themselves.

In 1884 electrical engineers were surprised to learn from Dr. Hopkinson that the Gaulard & Gibbs transformers gave something like 90 per cent. full-load efficiency. Since then alternating work has developed enormously; but a complete change has come over the transformers: they are almost always made with the iron circuit closed on itself. The closed iron circuit has been regarded as an enormous advance on the old form; but it is difficult to find any definite statement as to where the advantage comes in. It was for a long time assumed that almost any closed-circuit transformer would give an efficiency of something like 98 per cent.—in fact, that the loss in transformers might be neglected.

In a discussion on the relative merits of direct and alternate current distribution, Mr. Crompton said that the efficiency of the ordinary commercial transformer in a station was about 50 per cent.; and I need hardly say he was not believed. He laid particular stress on the small proportion of the total number of lamps installed really used. The loss in the iron in transformers has till lately been very much overlooked: if it is even a small percentage of the full load of the transformer, it mounts up very seriously in station work when the transformers are in circuit all day and all night.

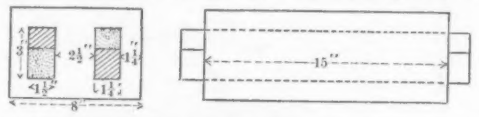


FIG. 11.—REPRESENTATIVE TRANSFORMER OF THE CLOSED CIRCUIT TYPE.

I had the honor of reading a paper before the British Association in 1889, in which the question of design for all-day loads was, as far as I know, discussed fully for the first time; and the relative proportions of iron and copper for closed-circuit transformers which gave the best results were given. At the same time I pointed out that the loss in iron was really such a serious matter that by a special design not only can a very much higher efficiency be obtained at light loads but that even at full load a new form is better in every way.

The principle of the "hedgehog" transformer is this: By using an open circuit the iron can be reduced in volume with a given induction. The mean length of the iron part of the magnetic circuit is considerably less, and more copper turns can be wound on without increasing this length much. The additional turns admit of a smaller cross section of core, so that the iron is enormously reduced. The loss in copper is somewhat increased; but, as the loss in copper is only serious at full load, this does not matter.

The old Gaulard & Gibbs form of transformer had the disadvantage of requiring a very large exciting current. Increased number of turns of copper reduces the exciting current; but, in addition, the ends of the core are spread out in a peculiar way, which again reduces the exciting current. The result is that the exciting current, though larger than in the case of closed-circuit transformers, is not a serious matter. The loss in copper is considerably smaller than the loss in iron in most closed-circuit transformers, and, as it varies as the square of the current, it is inappreciable except at full load, which very seldom occurs. The loss in iron is very small, so that the loss per day in ordinary working is very much smaller

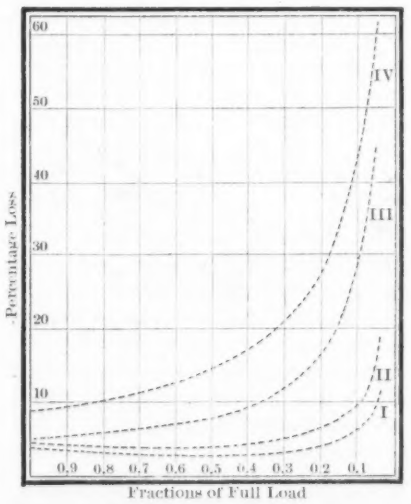


FIG. 12.—CURVES SHOWING TRANSFORMER LOSSES AT VARIOUS LOADS.

than in the case of closed-circuit transformers. Since my paper at the British Association, many makers have altered the proportion of their transformers considerably; but still it is impossible to get as good results with closed circuits.

Perhaps the best way I can make this clear is by a comparison of actual transformers. I am here confronted by a difficulty. If I select any particular closed-circuit transformer of a particular maker, all the other makers of closed-circuit transformers would say that I had chosen a bad example; while the maker himself would say that it was an old form, or that he now uses a quality of iron which wastes no power by hysteresis.

A great deal of unnecessary mystery has been made about the efficiency of transformers, and all sorts of roundabout ways of measuring or calculating it have been proposed, and sometimes tried. The matter is simple, however. The loss in the copper can be calculated if the resistance and current are known. The loss in iron in a given type of transformer depends on the quality of the sample used just as much as the loss in the copper depends on the quality of the copper used. I will therefore as-

*Continued from THE ELECTRICAL WORLD of March 28, 1891.

Industries, September, 1890.

sume the ordinary "96 per cent." quality of copper, and I will assume that the iron is as good as the soft iron tested by Professor Ewing. I have the best reasons for knowing that the iron used is generally much below this standard, so this assumption is considerably in favor of the closed circuits. Moreover, I am giving away the loss by Foucault currents, which is often considerable. Of course, any one is at liberty to assume that he has some particularly good iron; but in discussing the relative value of the two types of transformer, he must allow me the same quality of iron. In fact, I might assume a special quality of copper equally unknown to the trade in mine.

As an average size of transformer, one taking 2,000 volts and a frequency of 100, and giving 15 ampères at 100 volts, may be taken, and the working compared.

Though the theory of the "hedgehog" transformer was fully discussed in the British Association paper referred to, it may not be out of place to describe the construction of the commercial article.

A gun-metal casting forms the backbone of the transformer. It is cross shape in section, and at one end is spread out to form four legs. It also supports the lower flange, or cheek, of the winding. The four spaces have bundles of soft iron wire put in, so that the core is practically cylindrical. The cross-shaped core has been criticised on the ground that there are Foucault currents in it. The least consideration will show that there is no change of induction in it, and, therefore, no Foucault currents. The iron wire is bound tightly, and the two flanges are slipped into place. A gun-metal "spider" is then screwed to the top. It is finally held on by the eye-bolt, but temporarily a set screw is used. The core is then wound in a special lathe in the usual way. Both the terminal board and the coil flanges gave us a great deal of trouble till we found suitable materials. There is a great need of good insulating materials that will not warp, that will insulate perfectly, and that can be worked.

The electrical particulars of a 50 8-candle-power lamp transformer are as follows:—

Core, 13.5 inches long, 2.5 inches diameter. In taking the area of the core, allowance must be made for the space occupied by the backbone, and for the loss of room in using round wires. Maximum induction, 4,800. Loss of power in iron, assuming it to be of good quality, 13.5 watts. Primary, 3,920 turns of copper wire, 0.042 inch diameter; resistance, 37 ohms (warm). Secondary, 200 turns, $\frac{19}{0.042}$ inch; resistance, 0.098 ohm. Loss of power in primary at full load due to the transformed current, 21 watts; loss due to the exciting current—0.3 ampère—which is always on, 3.6 watts; loss in secondary at full load, 22 watts. Efficiency at full load, 96.15.

This transformer is shown to scale in Figs. 9 and 10.

Fig. 11 is a scale drawing of a closed circuit transformer I have taken as a representative. The primary is 400 turns of 0.042-inch wire, and the secondary 20 turns of 0.176 inch. The loss in copper at full load is 11.3 watts, and the loss in the iron 120 watts. At full load the efficiency is 91.95, or nearly 92 per cent. The diagram (Fig. 12) shows the percentage loss at various loads of the two transformers. The ordinates are percentage loss, and the abscissæ fractions of full load. Curve II. is the "hedgehog" and IV. is the closed circuit. It will be noticed that the "hedgehog's" efficiency increases slightly at first and keeps above 95 per cent. till the load is reduced to one-fifth, and above 90 down to one-tenth load and it then begins to fall more rapidly. The efficiency of the closed form, however, begins to fall at once, and falls rapidly. In house work the full-load efficiency is a matter of little or no consequence; the loss at very light loads is really important. A house that has a 50-light transformer is wired for 50 lamps, and that is the maximum load. As a rule, there are seldom more than 25 lamps on at any one time, and these are on during the evening only. The average load varies with the time of year and with the class of house. Shops, for instance, have full load for a short time each day; private houses have the lights in the hall and passages on the whole evening, with either the dining or drawing room, and for some time both the dining and drawing rooms are on. It will be a fair average if we take four hours of half load per day as the output of house transformers. This means an efficiency of 83.3 per cent. for the "hedgehog," and only 51 per cent. for the closed circuit. In other words, the waste in the closed circuit is between five and six times as great as in the open circuit.

It will, I have no doubt, be urged that various published tests have shown closed-circuit transformers to have efficiencies of, say, 95 per cent. I have elsewhere* examined some of these tests, and shown that, according to the figures given, the results can only be accounted for by the iron acting as a freezing mixture, and supplying power to the transformer, the total loss given being in some cases less than the loss by copper resistance. In some other cases too few data are given, so that it is impossible to say how the figures are obtained. In order that an efficiency test may be taken as reliable it must contain full particulars of the transformer. It is then possible to see whether the supposed efficiency of 95 per cent. is due to the type of transformer, to inaccuracies in the measurements, or to phenomenal iron. Of course it is not impossible some one may discover phenomenal iron which will be the salvation of closed-circuit transformers, but it will have to be very good. In Fig. 12, Curve III. represents the loss in a closed-circuit transformer with phenomenal iron having a loss of only 60 watts, or half that taken in the example. The dotted curve (I.) belongs to the open-circuit transformer with the same quality of iron; for, of course, the phenomenal iron is available for both. It will be seen that the ratio of the percentage losses is sensibly the same, so that the open-circuit transformer is improved nearly as much as the closed. In the case taken of half load for four hours a day, the loss in the closed circuit comes out more than four times that in the open, even without re-designing the "hedgehog." There is thus no chance of iron being found good enough to allow the closed circuit form to compete with the open. There is one objection to the "hedgehog" which must not be passed over, and that is the exciting current. The exciting current in the 50-lighter is 0.31; in the closed circuit it is 0.2; so that it is quite half as much again. Moreover, if a better quality of iron is discovered, it will lessen the exciting current in the closed circuit, but will make no perceptible difference in the open, unless it is re-designed. The exciting current does harm in two ways—it weakens the field of the dynamos at the central stations, and it gives rise to troubles in the station at light loads. For instance, if a station had 10 dynamos to run the full load, in the daytime three would be required to supply the exciting current, while in the closed circuit two would do. If the dynamos are direct driven, this means three engines running light instead of two; and engines running light are very wasteful. These difficulties are, however, to a large extent imaginary. The weakening of the fields is, in ordinary working, counteracted by stronger excitation. Running three dynamos instead of two or one does not involve running three engines; the engine should be uncoupled and the dynamos run as idle motors, supplying the exciting current necessary for the transformers. In the future, it is to be hoped that alternate motors will be used; and as they will be used chiefly during the times the load on the transformers is light, they will thus supply the exciting currents, and it will be unnecessary to run any idle dynamos. It must be remembered that the difference is only one of degree. Closed-circuit transformers have very considerable exciting currents; but it is most desirable to avoid any troubles, whichever kind is used. The solution of the difficulty lies in the employment of condensers. A condenser supplies the exciting current, so that the station dynamos supply a current sensibly proportional to the power used. Thus, in the daytime, with open-circuit transformers, a very small engine and dynamo will give all that is needed. More will be said about condensers presently.

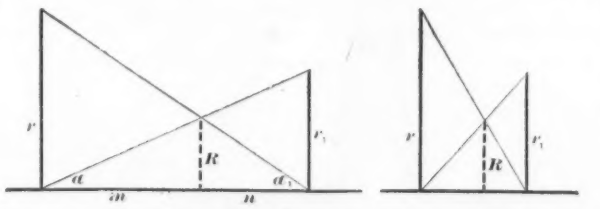
(To be continued.)

* "Induction, and Other Things," *Electrical Review* (London), October, 1889.

Simple Graphic Method of Calculating Resistance of Divided Circuits.

BY P. J. McFADEN.

In an issue of the *Elektrotechnische Zeitschrift*, of several months ago, attention was called, in passing, to a simple and quick way of arriving at the resultant resistance of a number of parallel circuits. The method, while it may not be new to all of the readers of THE ELECTRICAL WORLD, is probably so to the most of them, as I do not remember ever having seen it in any American or English journal, and even in the journal mentioned only a passing notice was made of it.



FIGS. 1 AND 2.—GRAPHIC METHOD OF CALCULATING THE RESISTANCE OF DIVIDED CIRCUITS.

The method, briefly, is as follows: On a base line erect at any distance apart two vertical lines, of lengths corresponding to the two resistances; then from the upper end of each line draw a line to the foot of the other, and from the point where these intersect let fall a perpendicular to the base line, then this perpendicular will represent, on the chosen scale, the required resistance of the two circuits. If there be more than two circuits the resistance thus found may be treated with that of the third circuit and so on until the ultimate resistance is found. It is quite immaterial at what distance apart the vertical lines be taken, as Fig. 2 and the proofs show.

The article referred to stated merely that the above was true, and gave no proof. The proof, however, is simple and is as follows:

1st. *By Plane Geometry.*—From the figure,

$$\frac{r}{m+n} = \frac{R}{n} \text{ or } nr = Rm + Rn \qquad (1)$$

$$\frac{r_1}{m+n} = \frac{R}{m} \text{ or } mr_1 = Rm + Rn \qquad (2)$$

whence $nr = mr_1$ and $n = \frac{mr_1}{r}$

Substituting in (1)

$$\frac{mr_1 r}{r} = Rm + \frac{Rmr_1}{r}$$

$$r_1 = R + \frac{Rr_1}{r}$$

$$\text{whence } R = \frac{rr_1}{r+r_1}$$

2d. *By Analytical Geometry.*—Taking the foot of the left hand vertical as the origin, the equations of the oblique lines are respectively

$$y = ax \qquad \text{where } a = \text{tang } \alpha = \frac{r_1}{m+n} \qquad (1)$$

$$y = -ax + r \text{ where } a = \text{tang } \alpha_1 = \frac{r}{m+n} \qquad (2)$$

$$\text{then } y = \frac{r_1 x}{m+n} \text{ or } (m+n)\, y = r_1 x \qquad (3)$$

$$y = \frac{-rx}{m+n} + r \text{ or } (m+n)\, y = (m+n)\, r - rx \qquad (4)$$

$$\text{from (3) } x = \frac{(m+n)\, y}{r_1};$$

$$\text{from (4) } x = \frac{(m+n)\, r - (m+n)\, y}{r}$$

Treating these values of x as simultaneous to obtain the y co-ordinate of the point of intersection

$$\frac{(m+n)\, y}{r_1} = \frac{(m+n)\, r - (m+n)\, y}{r}$$

$ry = rr_1 - r_1 y$, whence $y\,(r + r_1) = r\, r_1$, and $y = \frac{rr_1}{r+r_1}$

Thus in both proofs the values m and n are eliminated, showing that the distance between the two verticals is immaterial, while as a result we have the familiar value of the resistance of divided circuits.

Programme of the Patent Centennial Celebration.

The programme of the congress of inventors and manufacturers of patented inventions for the celebration of the beginning of the second century of the American patent system, to be held in Washington, D. C., April 8, 9 and 10, 1891, is as follows:

The first public meeting will be held on the afternoon of April 8, and will be presided over by the President of the United States. Addresses will be made by Hon. Charles Eliot Mitchell, of Connecticut, Commissioner of Patents, on "The Birth and Growth of the American Patent System;" Hon. O. H. Platt, LL. D., of Connecticut, U. S. Senator, on "Invention and Advancement;" Hon. Carroll D. Wright, M. A., of Washington, Commissioner of Labor, on "The Relation of Invention to Labor;" Hon. Samuel Blatchford, Justice of the Supreme Court of the United States, on "A Century of Patent Law," and by Hon. Robert S. Taylor, of Indiana, on "The Epoch Making Inventions of America."

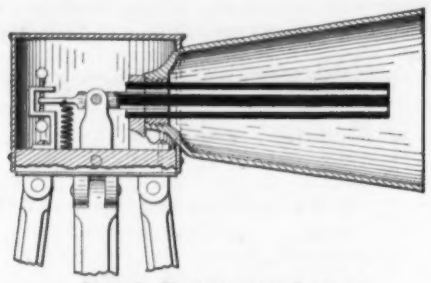
The second public meeting will be on April 8, and will be presided over by Hon. John W. Noble, Secretary of the Interior. Addresses will be made by Hon. John W. Daniell, LL. D., of Virginia, U. S. Senator, on "The New South as an Outgrowth of Invention and the American Patent Law;" Hon. Edwin Willitts, of Michigan, Assistant Secretary of Agriculture, on "The Relation of Invention to Agriculture," and by Mrs. Julia Ward Howe.

The third public meeting will be on the afternoon of April 9, to be presided over by Hon. Frederick Fraley, LL. D., President of the National Board of Trade and the American Philosophical Society, and charter member of Franklin Institute. Addresses will be made by Hon. Benjamin Bunterworth, of Ohio, U. S. House of Representatives, on "The Effect of our Patent System on the Material Development of the United States;" Octave Chanute, of Illinois, President of the American Society of Civil Engineers, on "The Effect of Invention upon the Railroad and other Means of Intercommunication;" Hon. A. R. Spofford, LL. D., Librarian U. S. Congress, on "The Copyright System of the United States; its Origin and its Growth;" Thomas Gray, C. E., B. Sc., F. R. S. E., of Indiana, Professor of Dynamic Engineering, Rose Polytechnic Institute, Terre Haute, on "The Inventors of the Telegraph and Telephone," and by Col. F. A. Seely, of Pennsylvania, Principal Examiner U. S. Patent Office, on "International Protection of Industrial Property."

The fourth public meeting will be on the evening of April 9, presided over by Prof. S. P. Langley, LL. D., Secretary of the Smithsonian Institution. The addresses of this session will be by William P. Trowbridge, Ph.D., LL.D., of New York, Professor of Engineering School of Mines, Columbia College, on "The Effect of Technological Schools upon the Progress of Invention;" Robert H. Thurston, A. M., LL. D., Doc. Eng., of New York, Director and Professor of Mechanical Engineering, Sibley College, Cornell University, on "The Invention of the Steam Engine;" Cyrus F. Brackett, M. D., LL. D., of New Jersey, Henry Professor of Physics, College of New Jersey, Princeton, on "The Effect of Invention upon the Progress of Electrical Science;" Prof. F. W. Clarke, S. B., of Ohio, Chief Chemist U. S. Geological Survey, on "The Relations of Abstract Scientific Research to Practical Invention, with Special Reference to Chemistry and Physics," and by Maj. Clarence E. Dutton, Ordnance Department, U. S. A., on "The

Influence of Invention upon the Implements and Munitions of Modern Warfare."

Anniversary Day, April 10, will celebrate the anniversary of the signing of the first American patent law, "An Act to Promote the Progress of the Useful Arts," by George Washington. At 10 A. M. there will be an excursion to Mount Vernon, where an address will be delivered by J. M. Toner, M. D., of Washington, upon "Washington as an Inventor and Promoter of Improvements." A special reception to inventors and manufacturers and the ladies who accompany them will be given at the Patent



IRISH'S PROJECTION LAMP.

Office April 8, at 9 to 11.30 P. M., by Hon. John W. Noble, Secretary of the Interior, and Hon. Charles Eliot Mitchell, Commissioner of Patents.

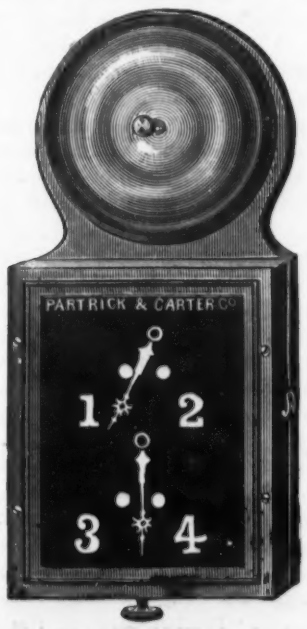
The fifth public meeting will be held on the evening of April 10, and is to be presided over by Prof. Alexander Graham Bell. Addresses will be made by Hon. William T. Harris, Commissioner of Education, on "The Relation of Invention to the Communication of Intelligence and the Diffusion of Knowledge by Newspaper and Book;" Prof. Otis T. Mason, Ph. D., of Virginia, Curator M. S. National Museum, on "The Birth of Invention;" Dr. John S. Billings, Curator U. S. Army Medical Museum, on "American Invention and Discoveries in Medicine, Surgery and Practical Sanitation," and by Edward Atkinson, Ph. D., LL. D., of Massachusetts, on "Invention in its Effects upon Household Economy."

Projector with Concentric Carbons.

Apropos of Mr. Stanley's recent articles on experiments with alternating current arcs, Mr. W. F. Irish sends an interesting sketch of a lamp for projection, in which that principle is utilized. Our diagram gives a good idea of its operation. The carbons comprise a rod concentric with the tube, and the arc is constructed by removing the rod from contact with the side of the tube into a central position. In some of the models a series coil is placed around the carbons to shift the arc into such position as seems desirable, or to push it forward so that it could be used, if necessary, as a blowpipe. This furnishes a very neat application of the arc to projecting, inasmuch as the incandescent surface is directly to the front, where it can be utilized to full advantage. Probably such a lamp would work better with alternating currents than with direct, as the consumption of the carbons would be more even. The arc, of course, can be retained if focused by a very slight shifting forward of the projecting mirror, and, if necessary, could be made to rotate so as to secure consumption of all parts of the tube.

The King Annunciator.

The accompanying illustration shows a new type of annunciator which has recently been put upon the market



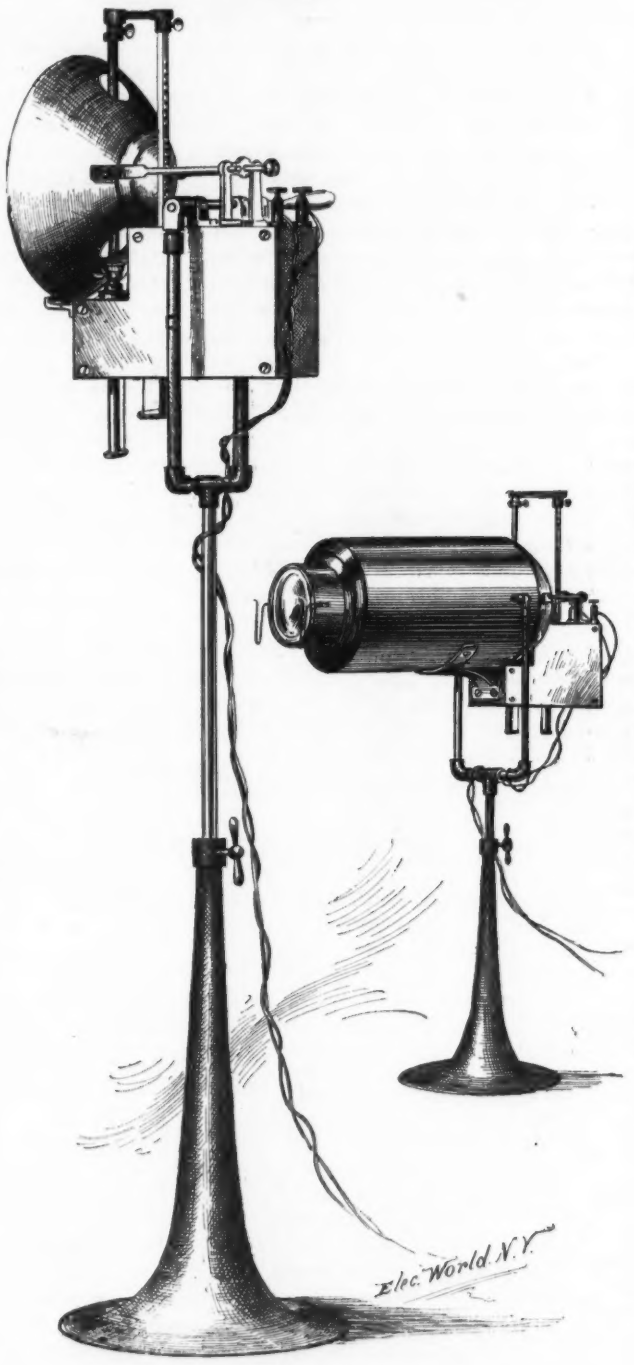
THE KING ANNUNCIATOR.

by the Partrick & Carter Company, of Philadelphia. It is made in three sizes for four, six or eight calls, and is fitted either with numbers or letters as desired. The one shown in the illustration on this page is a four-call annunciator. This type is a modification of the Partrick & Carter well-known indicating bells, and is of simple construction and perfectly reliable in its workings.

The Electro-Calcium Lighting Apparatus.

The calcium light, so extensively used in theatres for scenic and stage-lighting effects, has always been a great source of annoyance to theatrical managers on account of the bulk of the tanks for holding oxygen and hydrogen, and of some fears from occasional explosion, to say nothing of the expense and time for preparation and the additional men necessary to manipulate them. In some cases as many as 10 to 30 such lights are used, and the average cost of $2 per night for each calcium light as against 30 or 40 cents for the current used by the electric focusing lamp is an important factor in favor of the new departure.

To meet this demand the Scott Electrical Manufacturing Company, of New York, has perfected an arc-focusing lamp, and after extended trial at various theatres the lamp made by this company has proved to be among the best apparatus for stage and general theatrical lighting effects yet devised, especially in these days when theatres are so generally supplied with systems of incandescent lighting. This lamp works on any low-potential continuous incandescent circuit, so that it is only necessary to run



SCOTT FOCUSING ARC LAMP.

wires for the attachment of the lamps to the dynamo or system of lighting already installed in the theatre.

The mechanism of the lamp is such that it can be made to burn and feed automatically at any angle from below the horizontal to the vertical, this being of prime importance where it is desired to use the lamps above the stage, as on the flies or on the bridge, etc.

The switch or switches controlling the lamps may be on the stage or any other convenient place in the house, so that one man can manage all of the calcium effects, thus effecting a great saving.

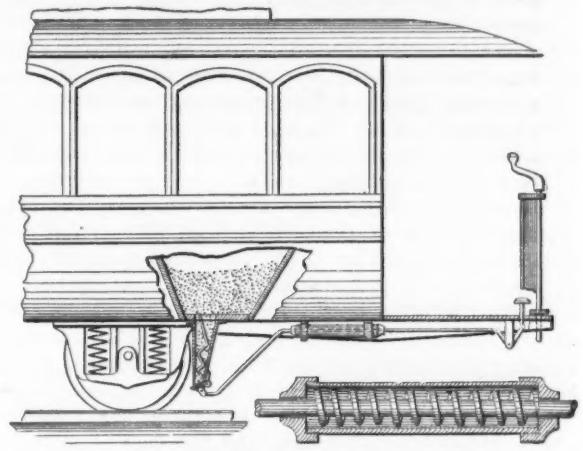
These lamps have been used in the Chicago Opera House for several months, and have entirely displaced the calcium lights, to the great joy of the management and the satisfaction of all who have seen the brilliant effects produced.

The cuts show the manner in which the usual calcium apparatus can be attached to the focusing arc lamp, the mounting of the lamp on an iron telescoping stand making this a very simple matter.

Fig. 1 shows the reflector mounted on the lamp for illuminating the stage from the gallery, etc. Fig. 2 shows the lens box, a tube of iron or tin, containing a plano-convex condenser, for illuminating a single figure or limited area on the stage. The olivet box (a triangular case, painted a dead white) is used for throwing a diffused light on scenery or stage.

The boomerang box (a stand containing a series of sliding frames of colored gelatine sheets for producing color effects) is placed in front of the lamp, either with or without a reflector, according to the effect desired.

Mr. E. M. Brown, of the company, has just returned from Boston, where the lamp was tried in the Hollis Street, Park and Globe theatres. These houses will be fitted out with electro-calcium apparatus in the near future. The Crystal Slipper Company has 10 of the lamps in use. Francis Wilson has ordered eight lamps for the "Merry Monarch." Some are used in St. Louis theatres, and several Philadelphia theatres are considering their adoption. The focusing lamp is also attracting the attention of photo-engravers, phototype and photographic people in this country as well as in Canada and Mexico.



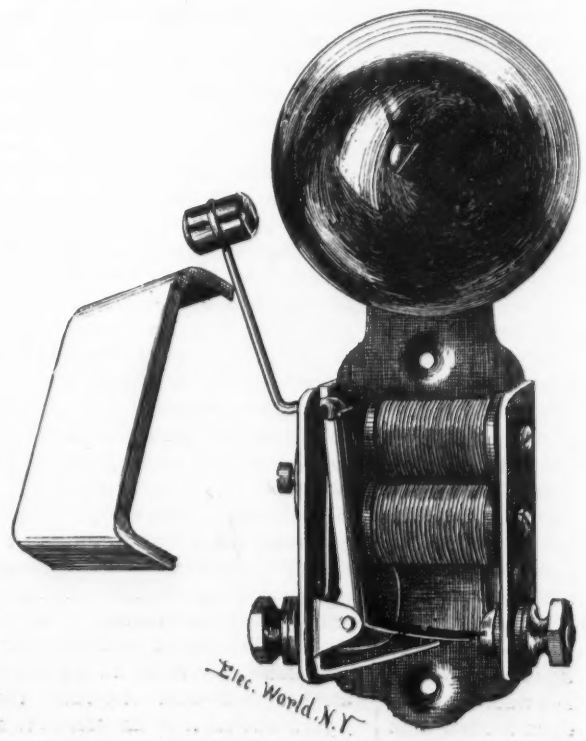
THE BATES SAND DISTRIBUTOR.

The Bates Sand Distributor.

In the running of electric cars where the constant attention of the motor man is required, and where both hands are at all times in use, the sand distributor, illustrated in the accompanying cut, proves of most decided advantage. As can readily be seen from the view given, the release valve is at all times under the control of the foot of the motor man or driver on the car. The greatest amount of serious trouble has been experienced in the forms of distributors heretofore in use by the clogging of the sand in the narrow neck of the containing bag. This difficulty is overcome by Mr. Bates in a simple and at the same time most efficient manner. A corrugated metallic ribbon extends from the opening up through the sand, and the slightest jar keeps the sand from becoming fast in the neck. Mr. Charles M. Rumrill, of 109 Liberty street, New York City, is the general agent in the United States for this sand distributor.

A Diminutive Bell.

The accompanying illustration shows in full size a little bell which has just been gotten out by Edwards & Co., of New York City. It is very simple in construction, and consists of very few pieces. The entire framework is made of one piece of stamped-out iron, the sides of the sheet being turned up to form the box for the magnetic



EDWARDS' ELECTRIC BELL.

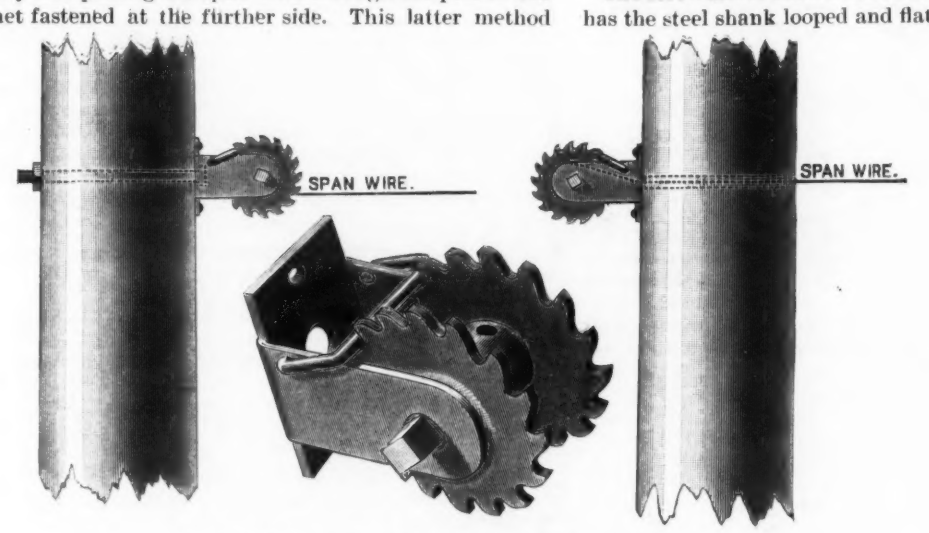
coils, as shown in the illustration. A tight-fitting cover, which is also shown in the illustration, is provided, which fits over the coils, making a practically dust-proof box for them. A buzzer of similar construction is also manufactured by the same firm, and both pieces of apparatus are very neatly finished. The cover, the bell and the hammer, and all of the exposed parts are nickel-plated.

A Simple Electrical Saw.

In a recent issue of the *Chemical News* Mr. H. N. Warren says: Whenever a powerful electrical circuit is closed by a platinum wire of suitable dimensions, the well-known heating effect of the same is at once manifested; yet no one seems to have been struck with the idea that the simple heated wire may be employed as a most effective disintegrator of the hardest organic compounds. A similar but more convenient article may be constructed as follows: It consists of two upright pieces of very stout brass or copper wire, connected at the lower extremities by a non-conducting medium, while across the top is secured a piece of moderately thin platinum wire. On thus connecting the apparatus by means of side binding screws to the terminals of about four Bunsen batteries, the platinum wire at once becomes heated to bright redness, and will be found to cleave the hardest wood with great facility. Owing, however, to the platinum wire frequently breaking, probably on account of its intimate contact with the carbon while at an elevated temperature, the author has devised and used with advantage a modified wire, formed by depositing metallic platinum upon fine steel wire, by exposing that substance to the action of the electric current in contact with an ethereal solution of platinic chloride.

A Street Railway Pole Ratchet.

The pole ratchet which is shown in the illustration on this page, while not strikingly novel in itself, has some points of interest. The Electrical Supply Company of Chicago has just placed it on the market. The illustration shows the ratchet and two methods of using it. It can be used in the old way, with bolt, washer and nut, or, as the Electrical Supply Company suggests, by discarding the bolt entirely and passing the span wire through the pole to the ratchet fastened at the further side. This latter method



RATCHET FOR STREET RAILWAY POLES.

would appear to offer decided advantages. The japanned ratchet is strong and light and is well finished.

The Flow of Current through an Electric Arc.

A recent number of the *Repertorium der Physik* contains a minute description of experiments made by H. Luggin to determine the laws which govern the flow of current across an electric arc between carbon points. Referring to the anode, Luggin distinguishes two kinds of discharges, the one taking place from the crater with considerable current density, and the other from the surrounding rim with a smaller current density, and at lower temperature. The vertical variation of potential was investigated by means of test-pencils inserted at different points. When the point of the test-pencil (a carbon rod 1.3 millimetres diameter) was placed well within the crater, the mean potential difference between the luminous surface of the anode and the layer of hot gases immediately contiguous to it was found from a mean of five observations to be 33.7 volts. The corresponding value at the cathode was found from six observations as 8.78 volts, whereas Uppenhorn had previously determined the potential differences as 32.5 and 5.2 volts. According to the author's estimate, that part of the potential differences between the electrodes which is caused by the transition from the solid to the gaseous conductor, and is therefore independent of the length of arc, amounts to 42.5 volts, which is the sum of the values above given.

The experiments were made with currents up to 20 ampères and electrodes of sufficient size in each case to prevent the arc from hissing. A series of experiments was made to determine the hissing point, which the author found is reached when the current density exceeds about one-half ampère per square millimetre (323 ampères per square inch) of crater surface. For hissing arcs the potential difference between the anode surface and the layer of hot gases next to it is greater, but it does not increase in proportion with the current density, and it would therefore be incorrect to ascribe this potential difference to the existence of a constant resistance. Although this consideration would naturally lead to the assumption that the arc is the seat of a counter electromotive force, the author has failed to detect the slightest polarization of the electrodes after the current was interrupted. By carefully contrived mechanism he was able to make connection between the electrodes and a delicate electrometer within the 0.005 part of a second after cutting off the current, and yet not a trace of charge could be detected in the electrometer needle. The author does not, therefore, believe it possible that the arc can be the seat of a counter electromotive force of 40 volts, as suggested by Dub.

The Model Shade Holder.

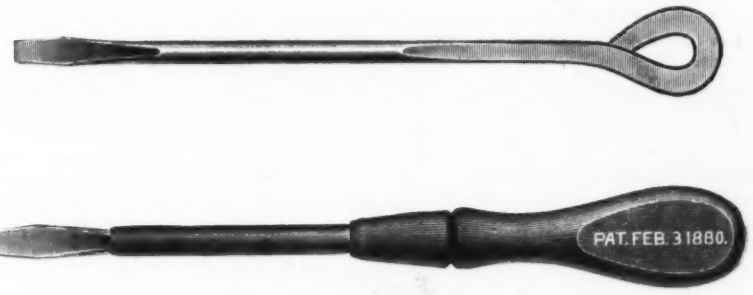
The accompanying illustration shows a new shade holder for incandescent lamps, which has just been brought out by the Steele & Johnson Manufacturing Company, of 35

SHADE HOLDER FOR INCANDESCENT LAMPS.

Howard street, New York City. The clamp by which the holder is fastened to the socket of the lamp, instead of being made in three or four pieces, as in the ordinary style of holder, is in this case made of one piece only, and this piece has a pair of lugs by which the supporting rim is attached to the clamp. The holder is very simple in construction, and appears to be very strong and durable. It will be known to the trade as the "Model Holder."

An Insulated Screwdriver.

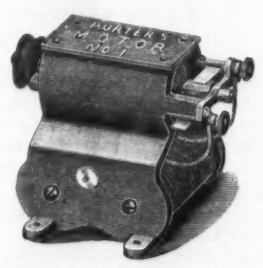
The screwdriver shown in the accompanying illustration has the steel shank looped and flattened at the end, all except the tip being then molded into a handle of vulcanized rubber. This material was chosen because it was considered the best and most durable for insulating purposes. It is handled in the West by George Cutter, of Chicago. Armed with such a screwdriver a lineman can work more safely around live circuits, where he would otherwise be in danger of getting a shock.



AN INSULATED SCREWDRIVER.

The Porter Motor.

The demand for small motors for a variety of work has brought out a number of types of different design. The one illustrated on this page has been recently put upon the market by Mr. M. D. Porter, of 177 Broadway, New York City, and is made in three sizes. The smallest size requires a difference of potential at its terminals of from four to six volts, and is intended for the operation of sewing



THE PORTER ELECTRIC MOTOR.

machines, and when applied to this work takes about six ampères of current. A difference of potential of two volts with this motor is sufficient to operate an eight or ten inch fan.

The Brooks System Abroad.

After minutely describing the details of this system as applied in a number of installations abroad, the London *Electrical Engineer* says of it: "Probably one of the largest fields of usefulness for the Brooks mains will be in connection the high-pressure three-wire alternate current distribution, for lighting and for alternate current motors, of which the installation to transmit several hundred horse power a distance of twelve and one-half miles at 25,000 volts, now being erected at the Oerlikon Works, Zurich, is the first and most noteworthy example. Examples of the use of underground transmission in towns where overhead wires cannot be employed will probably not be long in being seen in practice. The details of the Brooks mains for this system have already been carefully worked out." The installation referred to is one in which turbine wheels will be used in connection with generators to develop the current. The work now in progress will have a great deal of interest to those who have carefully watched the development of Mr. Ferranti's system, in which the highest voltage is 10,000.

The Electrical Association of Pennsylvania.

At a meeting of the representatives of various electric lighting companies in Pennsylvania at Harrisburg, Pa., on the 17th of March, a state electrical association was organized. The object is the local development of the electric light industry in Pennsylvania and to determine the best methods for assisting the state and municipal authorities in the formulation and enforcement of such laws and rules as will conduce to the best interests of the electrical community.

The following officers have been elected: President, Robert E. Wright, of Allentown, Pa.; vice-president, J. K. Ewing, of Uniontown, Pa., and secretary and treasurer, Clarence A. Wolle, of Bethlehem, Pa. The executive committee chosen is as follows: D. Hyman, of Harrisburg, Pa.; John A. Latham, of Mahanoy City, Pa.; B. F. Overholt, of Scottdale, Pa.; P. J. Ferguson, of Shenandoah, Pa., and E. D. Mullen, of Philadelphia, Pa.

Launch of the First Government Electric Pinnace.

Early in the month of March the first electric pinnace constructed for the British government was launched at the Chiswick works of Messrs. Woodhouse & Rawson. It is described by the *Electrical Engineer*, of London, as a very neat, well and solidly built open boat, 48 feet 6 inches long by 8 feet 9 inch beam, constructed of mahogany with teak fittings. She is built to carry 40 soldiers, and nearly the whole of the inner space is open, with seats around, under which the storage cells are placed, the total draught being 2 feet 3 inches when loaded. All machinery is out of sight, nothing save the double-bladed screw and the switch-handle being visible. The boat is fitted with 70 cells; those now used are E. P. S., but it is intended to fit her with a new type of cell—the "Epstein"—on which Mr. Epstein, accumulator manager for Woodhouse & Rawson, has been at work for some years, with, it is stated, extremely successful results. The new cells are of corrugated or grooved solid lead, chemico-electrically treated, and it is said of about one quarter the size and 25 per cent. lighter than the ordinary lead cells.

For the first trial, however, the ordinary storage cells were used, the launch being fitted with 70 cells of 19 plates each. The E. M. F. is therefore 140 volts. The motor is of a special make by Woodhouse & Rawson, of high efficiency, and made very low on its bearings. It gives 5½ to 6 h. p. at full speed, the screw being 22 inches across, working at 750 revolutions. The switch is arranged to allow full speed and half speed respectively ahead or astern. The charging current for the cells is 35 to 40 ampères during six hours, and the discharge at full speed 30 to 32 ampères, and at half speed 19 ampères. The specified speed is eight knots an hour on the measured mile under full load, or about 10 miles an hour. The boat can run 10 to 12 hours with one charge. The total weight is 4¾ tons, of which 2½ tons are cells and machinery.

The "Electric," as the new boat is called, was built primarily for the conveyance of troops between Chatham and Sheerness, along the River Medway, and is of almost exactly the same type as the ordinary government steam pinnace already used. It is expected that the electric pinnace will present considerable advantages over those now in use, as not only is the electric boat always ready at a moment's notice, but its actual carrying capacity is greater for the same size, while no skilled hands or engineers are necessary. It is the intention of the Royal Engineers to make a series of exhaustive tests of this type of boat, and Messrs. Woodhouse & Rawson are erecting a charging installation at Chatham, at which the charging will be simple and purely automatic.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

The General Market.—Although somewhat dull the market had an improved tone at the end of the week, and prospects are good for increased activity. An improved bank statement gave confidence at the closing hour. The scare concerning the exportation of gold has subsided. About $700,000 of gold was exported on Saturday, and it had little or no effect on the market.

The financial situation in Europe still continues to be unsatisfactory. The rumors of trouble between Germany and France, added to the many unfortunate failures in England, have kept financial matters in continued turmoil. This country, however, has nothing to lose in such prospects for Europe, as foreign wars invariably have a tendency to send stocks up.

The Census of the Electrical Industry.—From information recently obtained it appears that the United States Census Office has determined not to send out agents to collect information concerning the business, but intends to depend upon printed blanks which are sent to manufacturers and others interested in the electrical industry. The effect will be to get a lot of worthless and incorrect information. The blanks contain questions that no business man is likely to answer, besides requiring a great deal of work and presenting many opportunities for error. An agent could get the information correctly and get it without so much bother to the concerns questioned. The work properly done would cost very little more than at present, and if not done rightly the census can be put down as absolutely worthless, so far as statistics on the electrical industry are concerned. This matter is of greater importance to the business than is generally supposed, and should receive the serious attention of those interested in its welfare. If the census is to give out reckless information, based on returns which are likely mixed up, it is well to know it. If returns as to interest payments, bonds, etc., are not correct, it is going to hurt and depreciate bonds issued in the future, and may do great injury to the whole business.

Bell Telephone has had a good market and closed at 195 bid. The output of its telephones for the month ending March 20, 1891, was as follows:

	1891.	1890.	Inc.	Dec.
Gross output	5,717	5,179	538	....
Returned	3,167	1,648	1,519	....
Net	2,550	3,531	...	981
Since Dec 20:				
Gross	15,954	12,819	3,135	....
Returned	9,561	6,150	3,411	....
Net	6 393	6,669	....	276

Edison.—This stock has been active, and closed 2¾ points above last week's report. This stock may more fairly be represented at its "asked" price, 104

Thomson-Houston to a good market rose ½ point during the week, closing at 44 bid.

Westinghouse has had a fairly good market in its "common" stock during the week. What has transpired in the matter of the placement of the "preferred" stock is unknown so far as the general public is concerned, no statements having been given out by the directors of the company.

Phonograph Stocks.—Graphophone stock went up ⅜ of a point during the week, and, being listed in Washington, has a constant demand. Phonograph stocks, outside of the above-named, are very dull, and little or nothing is doing in them. Why not list North American Phonograph stock? F. Z. M.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, New York, on Saturday, March 28, 1891, in New York, Boston and Washington were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	80	80⅝
American Telegraph & Cable	100	14,000,000	81	82
Central and South American	100	5,000,000	145	160
Mexican	100	2,000,000	210	220
Commercial Cable Co	100	7,716,000	104½	109
Postal Telegraph Cable	100	5,000,000	39	41
Edison General Electric Co	100	9,503,500	102½	104
" " deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,929 400	....	....
Edison Electric Illuminating Co	100	2,567,800	79	....
United States Electric Light	100	1,500,000	30	....
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	43½	44½
" " preferred	25	4,000,000	24⅞	25½
" " Series C	10	400,000	9¼	10
" " Series D	10	120,000	6½	7
" International Co	100	1,000,000	....	....
Thomson Welding Co	100	1 000,000	....	....
" European Welding Co	100	1,000,000	55	65
Westinghouse Electric Mfg. Co	50	5,000,000	11⅞	12
Ft. Wayne Electric Co	25	4,000,000	12⅜	12¾
Telephone:				
American Bell	100	12,500,000	*194	196
Erie	100	4,800,000	49	49½
New England	100	10,304,600	50	....
Mexican	10	1.280,000	90c.	1
Tropical American	10	400,000	75c.	1
MISCELLANEOUS.				
Edison Phonograph Doll	10	1,000,000	....	1
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	34
Chesapeake & Potomac	100	2,650,000	58½	63
American Graphophone	10	600,000	6	6½
United States Electric Light (Washington)	100	300,000	167	180
Eckington and Soldiers' Home Electric Ry	50	352,000	56⅝	57⅜
Georgetown and Tennallytown	50	200,000	60	65

*Ex dividend.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

Chicago	$225@$245	Cumberland	$60@ $62
Central Union	56@ 57	Wisconsin	118@ 120
Michigan	85@ 86	Bell of Missouri	160@ 165
Great Southern	30@ 32	Iowa Union	20@ 22
Colorado	34@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell	40@ 43		
ELECTRIC LIGHT STOCKS.			
Chicago Arc Light and Power	$96@ $98	Chicago Edison	$140@$150

NEW INCORPORATIONS.

The Souhegan Electric Light and Power Company, of Milford, N. H., was noticed last week under a slightly different and incorrect name. The above company has recently been incorporated. Mr. C. E. Pendleton, well known in New England, is the superintendent of the new company.

The Arnold Electric Manufacturing Company, of Chester, Pa., has applied for a charter. This company will carry on "the manufacture of iron or steel or any other metal and the carrying on of the mechanical or manufacturing business of making and selling engines, machinery, electric lighting, heating and power plants, electrical specialties and supplies, dynamos, motors and storage batteries."

Waynesboro, Pa.—An electric light and power company has been organized with a capital stock of $15,000. The officers are: President, E. E. Elden; vice-president, W. H. Brown; secretary, D. H. Geiser; treasurer, W. T. Omwake, and J. F. Geiser, superintendent. A plant with a capacity of 40 arc lights and 700 incandescent lights will be installed.

AFFAIRS OF THE COMPANIES.

New England Telephone and Telegraph Company has declared a dividend of 75 cents per share, payable May 15.

The South Pittsburgh Electric Light and Power Company, of South Pittsburgh, Tenn., has declared a dividend of 5 per cent. This is one of the most successful plants in the United States.

The Oakland (Cal.) and Berkeley Rapid Transit Company has amended its articles of incorporation from 11 to 5 directors, who are John W. Coleman, George W. McNear, J. E. McElrath, W. H. Martin and A. T. Eastland.

The Lancaster Electric Light Company has elected George Matt president; William G. Wagenhals, secretary; Philip Rising, treasurer; J. B. Orman, E. H. Bininger, Philip Rising, George Matt and W. G. Wagenhals, directors.

The Commercial Cable Company, of New York City, held its annual election of directors last week at the Washington Building, No. 1 Broadway. The following ticket was elected: James Gordon Bennett, A. B. Chandler, G. S. Coe, C. R. Hosmer, G. G. Howland, R. Irvin, Jr., J. W. Mackay, Jr., E. C. Platt, T. Skinner, Sir D. A. Smith, W. C. Van Horne and G. G. Ward. J. W. Mackay, Jr., replaces Hector De Castro, and E. C. Platt succeeds W. L. Scott. With these two exceptions the entire board was re-elected. Out of 77,160 shares there were 51,660 shares represented at the meeting.

The East End Electric Light Company, of Pittsburgh, held its annual meeting last week. Mr. A. T. Rowand, the president of the company, tendered his resignation on account of ill-health, and his place was filled by the election of Mr. J. H. Willock, who had occupied the position of vice-president of the company. The annual report shows the following: Gross earnings for 1890, $88.341.39; operating expenses of all kinds, $47,610,41; making the net earnings $40,733.98. On January 1, 1891, the company's surplus was $15,574.77. The total assets of the company are $803,887.08, and the liabilities $758,711.60. The capital stock is $500,000.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, March 30, 1891.

Mr. C. Tennant Lee, of the Gould and Watson Company, manufacturers of molded mica specialties, in Boston, Mass., was in New York last week.

Messrs. Read and McKibben, the well-known electrical engineers, will remove from 32 Liberty street to 2 Wall street, corner Broadway, on or about May 1.

Mr. E. P. Shaw, of the Newburyport Car Company, at Newburyport, Mass., and Mr. Stearns, of the Bemis Car Box Company, of Springfield, Mass., were in New York last week.

The Brooklyn City Railway Company has voted to issue $6,000,000 in bonds. The issue is to be used in supplying the present lines of road with electric power and to extend the road to Gravesend.

The Barriet Motor Company has installed one of its 2½ h. p. slow speed motors in the warehouse of R. J. Chard at 96 Pine street New York. This motor runs a hoisting elevator and is doing excellent work.

Mr. W. B. Ferguson, New England agent of the Rae system, while in New York this week stated that his company now has two cars on the electric street railway at Augusta, Me., four at Gloucester, Mass., and one on the electric railway at Salem, Mass. The cars are all reported as working very satisfactorily.

The Brooklyn Institute Lectures on electricity for the month of April will be: On April 3, by Mr. Charles Hewitt, on "Street Railway Motors and their Regulation," illustrated by diagrams and lantern views, and on April 17 a lecture by Mr. Edward H. Lyon on "The Theory and Construction of the Telephone."

Messrs. Thompson, Crawford & Co., of the World Building, New York, are building seven miles of electric railway at Lancaster, Pa. There will be ten cars equipped with Brill trucks and Edison motors, and in the power plant Corliss engines and Edison generators will be used. The road will be in operation about the middle of May.

Mr. John A. Brill, of Messrs. J. G. Brill & Co., the well-known builders of street cars and trucks, was a visitor to New York this week. This company has just equipped the Spokane Falls (Wash.) street railway with 18 eight-wheel cars mounted on the new Brill No. 11 truck. The Spokane company operates 15 miles of street railway.

The New York Electrical Exchange Building.—Among the many electrical companies which have secured offices in the above building are the following: The Thomas Murray Company, Mr. Frank M. Beardsley, the McCreary Electrical Specialty Company. The Niles' Tool Works, of Niles, O., has also obtained rooms in this building.

The Thomas Murray Company, of this city, engineers, contractors and builders of electric and steam railways, will, after April 1, occupy four commodious offices in the new "Electrical Exchange Building," corner Liberty and Washington streets. This company has now in course of construction and under contract over 128 miles of electric railways.

Mr. Walter S. Glover, formerly ticket agent of the Old Colony Railroad at Brockton, Mass., and later manager of the visitors' bureau in New York, will hereafter act as general sales agent for M. D. Porter, the well-known motor manufacturer, whose factory is in Greenwich street, and office at 177 Broadway, New York. Those who have known Mr. Glover in railroad circles can safely predict for him a successful business record.

Lighting the Tunnel.—The Board of Railroad Commissioners has ordered the railroad companies to string incandescent electric lights in one of the side tunnels in Fourth avenue, New York, on the side opposite the signals, to test the question of their use practically, and also the problem whether electric lights will penetrate fog, smoke, etc., further than lights now in signal lamps, with the view of substituting electricity for oil in such lamps.

City Wire Question.—Mayor Grant, President Henry D. Purroy, of the Fire Department, and Mr. Wheeler had a long discussion in the Mayor's office last week as to the best way of getting down the duplicate wires and poles Mr. Wheeler had reported as existing. Mr. Purroy declared that most of the complaints against the fire wires were unfounded. The Mayor proposes to see that the Board of Electrical Control's resolution, compelling the companies to label these poles and to report to the board what poles they own, shall be complied with. L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, March 28, 1891.

The Salem (Mass.) Electric Lighting Company has declared a quarterly dividend of 1½ per cent.

The Thomson-Houston Electric Company has been awarded the contract for lighting Parkersburg, W. Va.

The Eastern Electric Supply and Construction Company has appointed Mr. J. Edward Wallace manager of the railway department and Mr. J. S. Butler, formerly with F. M. Kimball & Co., as travelling agent.

The Railroad Commissioners have granted permission to the Merrimac Valley Street Railway Company to increase the stock from $80,000 to $250,000 in order to equip the line for electricity, which will be done at once.

A Power Transmission Plant.—It is proposed to utilize the power of the Woonosoki River in Vermont going to waste (estimated at some 600 h. p.) by erecting a power plant about eight miles from Burlington, Vt., on that river.

Professor Elihu Thomson gave a lecture before the members of the Thomson Scientific Club last week on "Energy," actual and potential. Professor Thomson will deliver a lecture on electricity in Odd Fellows' Hall, Lynn, Mass., April 1, for the aid of the Electric Mutual Benefit Association. A large attendance is assured.

The Electric Club of Massachusetts Institute of Technology, under the charge of Mr. Puffer, made a visit of inspection to the Edison electric light station on Head Place last week. These visits to the various electric plants are proving to be very beneficial in many ways, bringing the student to realize more fully than would be otherwise possible the practical application of the theories and rules previously learned.

Mr. George W. Mansfield, of the Thomson-Houston Electric Company, gave a very interesting lecture last week before the Society of Arts upon the "Relative Value of Steam Railways as compared with Street Railways." The lecturer gave an array of statistical figures that were very suggestive of the future possibilities of both systems. According to his figures there are 161,395 miles of steam railroads in the United States using 23,000 passenger coaches and carrying annually 495,000,000 people, against 8,282 miles of street railways having 29,000 cars and transporting 3,000,000,000 persons yearly. C. A. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, March 28, 1891.

The Electrical Supply Company exhibits in its show window a large card on which appears "To Rent." The new offices and store are on Michigan Avenue.

Mr. Joseph Ketchum, of the firm of Joseph Ketchum & Co., manufacturers of insulating paint, tape and compounds, of Brooklyn, N. Y., was a visitor in Chicago last week.

Prof. J. P. Barrett, Chief of the Bureau of Electricity of the Worlds' Fair, has been confined to his home nearly a week by a severe attack of the grippe. His early recovery is expected.

Mr. W. A. Willard, formerly general sales agent of the Interior Conduit and Insulation Company, has accepted the position of district auditor of the Edison General Electric Company, for the Central District, with headquarters at Chicago.

Col. William Hood, the genial and well known representative of the Accumulator Company, in Chicago, has decided to carry a full line of electrical specialties, including small motors, Walker ammeters, &c. Mr. Hood has secured ample space for the exhibition of the various novelties at 239 La Salle street, Chicago.

The Bain Electrical Manufacturing Company, of 47 South Jefferson street, Chicago, has lately submitted an estimate to an electrical company in Spain for about 1,600 h. p. in dynamos and motors, the sizes ranging from 100 to 500. The machinery is for use in long distance transmission at an exceedingly high voltage.

Mr. F. S. Terry, manager of the Electrical Supply Company, 171 Randolph street, Chicago, has returned from an extended pleasure trip through the South. It was found necessary to introduce many of his old friends before they were able to recognize him, owing to certain changes in his appearance. No explanation of how it happened has yet been offered.

The Chicago Electric Manufacturing Company has removed to the second floor of the building at 73 West Jackson street, Chicago. The new quarters have been fitted up expressly for this company and afford it largely increased office and shop room. New tools and machinery have been added to the equipment, making it possible to handle with greater facility the rapidly increasing business. H. C. E.

SOUTHERN NOTES.

NORFOLK, Va., March 28, 1891.

Anstell, Ga.—The city council is obtaining estimates on the cost of an electric light plant.

Lakeland, Fla.—The Lakeland Electric Light Company is preparing to erect an electric light plant that will cost about $6,000.

Tallapoosa, Ga.—New machinery is being added to the electric light and power plant of the Vernon Electric Light and Power Company.

Falls Church, Va.—Mr. N. E. Church and others contemplate establishing an electric light plant, together with several other enterprises.

Newberry, S. C.—The city council is inviting proposals for the establishing of an electric light system, the cost not to exceed $5,000 a year.

Atlanta, Ga.—Alfred A. Glacier, representing a syndicate composed of capitalists from Boston and New York, has purchased the Atlanta Street Railway and the Atlanta and Edgewood Elec-

tric Line, and is stated to be in negotiation for the purchase of other lines in the city, all of which will be transformed into an electric system.

Charleston, S. C.—The West End Railway Company has applied to the city council for a franchise to construct and operate an electric railway.

Vicksburg, Miss.—The Hill City Electric Light Company will shortly issue $20,000 worth of bonds for the purpose of improving its electric light plant.

Basic City, Va.—The Basic City Mining, Manufacturing and Land Company has concluded arrangements for the erection of an electric light plant.

Galveston, Tex.—The Citizens' Electric Light Company has decided to increase the capacity of its plant by adding a 500 h. p. dynamo and four boilers.

Nashville, Tenn.—A company has been incorporated by D. B. Cooper, G. H. Witworth, P. P. Pickard and others to construct and operate an electric light plant.

Meridian, Miss.—New machinery has been recently put in for the electric light and power plant of the Thomson-Houston Electric Light and Power Company.

Winchester, Tenn.—The Franklin County Improvement Company is interested in the organization of a company for the purpose of establishing an electric light plant.

Martinsburg, W. Va.—The State legislature has authorized the city council to erect an electric light plant, and the mayor of the city now desires estimates on the cost of the proposed plant.

New Orleans, La.—The Consumers' Electric Light Company, Limited, will hold a meeting on April 11, to take into consideration the advisability of increasing its capital stock from $40,000 to $150,000.

Ashland, Ky.—The National Water Supply and Guarantee Company has been incorporated with a capital stock of $1,000,000 for the purpose of erecting an electric light plant. The incorporators are: J. M. Gardiner, Wm. Poage, and P. G. Nicols.

Little Rock, Ark.—The Capital Street Railway Company contemplates changing its motive power to electricity, and has already purchased a site upon which it is intended to build a power house, work upon which will begin immediately.

Americus, Ga.—The electric light plant of the gas works, belonging to the Americus Electric Light and Power Company and the Americus Gas Light Company respectively, have been purchased by B. C. W. Thom and others, of Baltimore, Md. A new company will be organized and both of these plants improved and enlarged.

Petersburg, Va.—The commissioners to assess compensation to be paid by the Postal Telegraph Cable Company to the Norfolk & Western Railroad Company, for the right of way along the road between Petersburg and Norfolk, have been in session. Joseph B. Tree, superintendent of the Western Union Telegraph Company, was kept on the stand an entire day.

Albany, Ga.—The business portion of the city is now lighted up by the arc lights, which have been substituted temporarily to supply the place of the incandescent lights the machinery for which was disabled in a severe storm which took place several nights ago. The citizens are so much pleased with the arc lights that their temporary use may lead to their permanent adoption by the city council.

Parkersburg, W. Va.—The Thomson-Houston Electric Company, of Boston, Mass., has been awarded the contract of furnishing the city with electric lights. Notwithstanding this agreement a bill has been introduced in the legislature authorizing the city to "generate distribute, use and sell electricity," and it is presumed that the city intends at some future time to establish an electric light plant of its own.

Shendun, Va.—The Grottoes Company is expending $20,000 in the establishing of an electric light and power plant. For two months work has been progressing on the necessary building, which will be a handsome and substantial one of stone. Five hundred horse power will be obtained from the river and transmitted by electricity to different manufacturing establishments through the town, besides supplying lights to the streets and houses.

Raleigh, N. C.—There has been some hitch in the construction of the contemplated electric street railway. The Edison Company recently commenced taking up its material for the purpose of removing same to Charlotte and other points south. The city authorities have forbidden the removal of the poles which this company put up to support the trolley wires of the street car line. Another company will probably take hold and build the line.

Warrenton, Va.—The East Virginia and Warrenton Improvement Company was organized recently with ample capital and with some notable names among its stockholders. The president is Hon. John W. Daniel, United States senator from Virginia. This company is now in negotiations for the establishing of an electric light plant in this place. Warrenton is a growing town and its population consists of progressive people. It is within only three hours' ride of Washington city and is every year becoming more popular as a summer resort.

Richmond, Va.—Prof. Chas. H. Winston, of the faculty of Richmond College, has inaugurated a series of lectures on electrical subjects. The general title of these lectures, which are free to the public, is "The Old Electricity and the New." Three lectures are now announced—the first to be on "The Electricity of the Influence Machine," the second on "The Electricity of the Battery," and the third on "The Electricity of the Dynamo"—a historical survey of the successive steps from Galvani's original experiment with the frogs down to the present era of telegraph and telephone and ocean cables, with illustrations, both by lantern slides and by selected experiments. The subjects are treated popularly, so as to be within the comprehension of the average citizen.

V. N. B.

WASHINGTON, D. C., March 28, 1891.

Telegraphers' Convention.—A convention of the Old Timers' Association and Society of Military Telegraph Operators is to be held in this city on Aug. 19 and 20 next. As there are over 100 telegraphers in this city who were in the business 20 or more years ago, many of whom are still engaged in the work, it is proposed to have a gathering of the same in the near future to take into consideration what is deemed best for the proper entertainment of the coming clan. Many of the inactive telegraphers in this city can now be classed from a United States Senator down, and as the coming meeting will be one of great interest, composed of workers from far back in the 40's down to the present time, it is to be hoped that all interested in the perpetuation of the associations of the "American Telegrapher" will send in their names and addresses to the chief operator Western Union Telegraph Office in this city, that they may be duly notified when and where to meet.

ENGLISH NOTES.

LONDON, March 11, 1891.

The London-Paris Telephone Cable.—The government cable steamer "Monarch" has been for some little time past lying at Dover, with the London-Paris telephone cable on board, ready to lay it the moment the elements permitted. On Monday, the weather having moderated somewhat, the "Monarch" landed the shore end at Calais, and commenced paying out the intermediate portions. When midway across the Channel she encountered a violent snowstorm, but the operation was proceeded with, and the English shore end will shortly be connected up. Within the next day or two, therefore, the capitals of England and France will be in telephonic communication with each other.

St. James and Pall Mall Company.—This company, whose station is situated in the heart of the richest portion of London, has succeeded, after boring to a depth of nearly 300 feet, in obtaining a plentiful supply of water, the yield being now at the rate of 1,060,000 gallons per week. This success has made the vestry anxious to repeat the experiment in other parts of the parish with a view to obtaining water for local purposes. Perhaps the next best thing the St. James Company can do would be to bore until they find coal. There are periodic reports that coal has been found under London, and as the St. James Company is in some danger of injunctions owing to the nuisance caused to the surrounding neighborhood by the constant processions of coal carts, wending their way to the station, it would benefit perhaps more than any other commercial concern by such a find under its property.

Local Authorities and Electric Traction.—The North Metropolitan Tramway Company, which has a few accumulator cars running on a branch line, obtained a bill last year, empowering it with the consent of the local authority to employ electric traction throughout its system. The company is anxious to carry out the provisions of this bill, but has hitherto been prevented from doing so by the action of the West Ham local Board, which refuses to give its consent on any other terms than that electric traction shall be replaced by horse traction at 24 hours' notice. The Tramway Company endeavored to overcome this unreasonable stipulation by bringing in a short bill this session empowering the Board of Trade to act as arbitrator This bill was supported by the Board of Trade itself. Nevertheless, the select committee before which it came up for consideration has decided that the favor asked cannot be granted.

Probable Litigation in Connection with Transformer Substations.—One result of the feeling of distrust of transformer working which has arisen in the public mind owing to the fire at the Grosvenor Gallery substation last autumn is a lawsuit now pending between Messrs. Savory & Moore and the London Electric Supply Corporation. It was mainly owing to the constant succession of motions for injunctions which was brought against this company in its "pioneer" days that Mr. Ferranti's Deptford scheme was so readily adopted, and all moving machinery transported to a spot seven miles from Charing Cross. Messrs. Savory & Moore, a well-known, Bond street firm, however, are not yet content, and, holding that a transformer substation is a grave source of danger to the neighborhood, demand its removal from their vicinity. If the law decides that transformer substations are a grave public danger and an injunction is granted, Mr. Ferranti will be confronted by a legal difficulty scarcely less formidable than the electrical ones he has at last succeeded in overcoming.

Central London Railway Scheme.—The Central London Railway Bill is once more being submitted to the closest scrutiny by a select committee of the House of Commons. Among those who gave evidence in support of the scheme were Sir Benjamin Baker, Mr. Greathead, Sir John Fowler and Dr. John Hopkinson. In the course of the examination of these witnesses some interesting facts with regard to the proposed scheme were elicited. The line, as I have already mentioned, will run from the suburban district in the west, known as Shepherd's Bush, past Hyde Park, along Oxford street, Holborn, Cheapside to the Bank of England, a distance of about six miles. The track will run at an average depth of 50 feet, dipping at times to 80 or 90; the worst gradient being one per cent. There will be a two minutes' service, the trains running at an average speed of 15 miles per hour, and each consisting of four cars and capable of carrying 336 passengers. The total rolling load will be 120 tons. There will be 13 stations in all. The generating depot will be situated at the Shepherd's Bush end of the line, and will have a capacity of between two and three thousand horse power. The proposed capital of the company is three and a half million sterling. Mr. Greathead gave striking evidence with regard to the tremendous overcrowding on the City & South London Railway during the busy hours of the day. Sir Benjamin Baker said that when he was in America last autumn he took care to make himself thoroughly well acquainted with American experience in connection with electric traction and found it entirely corroborated his own view on the subject, and he challenged the opponents of electric traction to repeat this year what they said last year with regard to American experience. Dr. John Hopkinson estimated the working expenses of the line at a trifle under 9d per train mile The opponents to the scheme, although formidable from the point of view of numbers, do not in most cases now assert that there is no need for the line, and that it would be detrimental to the public weal. In one instance the counsel pursued a somewhat amusing line of argument, making most desperate efforts to show that the line could not possibly prove remunerative. The scheme, he said, had been promoted by ingenious gentlemen from the other side of the water, who had come across the ocean to see what they could make out of the simplicity of the Londoner. The whole thing was "a clever Yankee speculation." He implored the committee not to hand over the main streets of this, the richest metropolis in the world, to a "speculating syndicate on the strength of the statements of enterprising citizens of the United States." The most formidable tussle is in connection with the questions of royalty for the use of the subsoil, royalty to the local authorities, reduction of fares in the event of the enterprise proving more than reasonably remunerative, and the purchase of the undertaking on favorable terms by the County Council after 42 years. With regard to the latter point the committee have decided that there is no need for the insertion of any such clause in the bill. With regard to the first point it has been decided to leave the matter open to be settled in a court of law if occasion should arise. The remaining points will no doubt form the subject of further discussion. The committee has decided that the preamble of the bill is proved, and will to-day commence the consideration of its clauses in detail.

LONDON, March 18, 1891.

The National Telephone Company.—This company proceeds steadily with its process of absorption, and last week it was announced that the South of England Telephone Company had followed the example of the United, the Lancashire and Cheshire, and the Northern District companies, and had amalgamated with the Telephone Colossus. Meanwhile the inauguration of the Mutual Telephone Company's rival exchange at Manchester has not been without result. The subscribers to the "Border" district of the National Company's system being disappointed at the amount of reduction of their rentals, have withdrawn in a body and are, it is stated, in negotiation with the Mutual Company, to provide their locality with a cheaper and more efficient system of telephonic communication.

The Electric Tanning Patents.—In January last the Worms & Balé electric tanning patents were upset on the ground of prior publication, and the patent of Mr. Groth was held not to be an infringement of it, on the ground that his process differed essentially from that of Messrs. Worms & Balé. The prior publication was of a somewhat peculiar character, inasmuch as it was constituted by the arrival in this country of the *Official Gazette* published by the American Patent Office, and the patentees, unaware of this, applied for the full English patent instead of for the restricted patent, as they should have done under the circumstances. The British Tanning Company, which owns the Worms & Balé patent, deprived of its *raison d'être* by the invalidation of this patent, have taken the unusual course of endeavoring to get a private bill passed by Parliament, rehabiliating the Worms & Balé patent, but it is hardly likely that the company will be successful in its attempt.

The St. Pancras Vestry Electrical Exhibition.—The little electrical exhibition got up by the St. Pancras Vestry with a view of assisting its intending customers in their choice of electric light fittings was opened on Monday by the Lord Mayor, and has proved a decided success. The exhibition is crowded every evening, and the display of fittings, switches, motors, meters, etc., is most creditable. One novelty, the Teague wattmeter, is perhaps worthy of special mention. This instrument may be briefly termed an improved Ferranti meter. It consists essentially of an electromagnet, excited in shunt, and a hollow rotating copper cylinder inserted in an annular space bored out in the pole piece of the magnet. The axis of the copper cylinder projects at the bottom into a mercury trough, while the external surface dips at its lower end into another mercury trough. The series current ascends the axis of the cylinder, radiates by means of the metallic cap at the top to the exterior, and passes thence down to the second mercury trough.

The London Electric Supply Corporation.—Nothing very startling transpired at the meeting of this corporation on Friday last. The chairman had the usual tale to tell of constant expenditure and comparatively small income, various misfortunes and continued confidence in the ability of Mr. Ferranti to ultimately overcome all difficulties. A few figures with regard to this company's financial concerns may be of interest to your readers. Its authorized capital is 1¼ million sterling, of which some £700,000 have been paid up and nearly £650,000 expended, leaving a balance in hand of about £60,000. During 1890 no less than £143,000 have been expended, the biggest item being mains, which are responsible for £70,000, while some £33,000 have been expended on machinery at Deptford. The profit and loss account shows a strange equilibrium, the expenses of generation, distribution and management during 1890 having amounted to nearly £29,000, and the *total* revenue is only some £20 in excess of this sum. The actual income from sale of current was £26,000, of which two-thirds were sold by meter.

The London Subway Railway Schemes.—I wrote you in a recent letter that there were three electric subway railway schemes submitted to Parliament. These schemes were the Central London Railway, running right across the metropolis from east to west; the northern extension of the City & South London Railway, which when carried out would make that line run right across the metropolis from north to south, and the small line for connecting the districts of Paddington and Kensington. The Central London Railway bill has so far proceeded successfully. The promoters of the Kensington and Paddington subway have been obliged to substitute cable for electric traction, owing to the representation of the Science and Art Department. On Tuesday the bill for the extension of the City and South London Railway was thrown out by a committee of the House of Commons, owing in a large measure to the refusal of the promoters of the bill to effect what was termed "a physical junction" with the existing line. Two out of the three electric traction schemes have thus already received their *quietus* and it is by no means certain that the Central London Railway bill will be more successful than last year in that grave of useful schemes, the House of Lords.

Overhead Wires in London.—The bill for the regulation of overhead wires and the removal of ownerless aerial lines, which has been brought in by the County Council, passed to day through the Select Committee of the House of Commons, but not without emasculation. Among the principal demands put forward by the London County Council in their bill were: (1) Compulsory powers of entrance by their inspectors on to private property for the purpose of inspection and removal. (2) Taxation of the owners of overhead wires to pay for the expense of supervision. (3) The compulsory removal of overhead wires into existing subways and the charge of a small annual rental for use of the same. The clauses embodying these powers have one and all been excised by the committee and the proper regulation of overhead wires in this metropolis has once more been rendered nearly impossible. Two items of information came out during the examination of the witnesses for the National Telephone Company, which may be of interest. The National Telephone Company has no less than 12,000 miles of overhead wire in London and pays the sum of £37,000 every year to the Postmaster General, as a substantial recognition of his rights.

Opposition of the Post Office to the Boy Messenger System.—Whenever complaint is made in this country with regard to matters telegraphic we are always told that the system is the finest and cheapest in the world. However this may be, the public is frequently reminded that state management of the telegraphs is not without its drawbacks. During the last week a vigorous correspondence has been going on between the Postmaster General and the Boy Messengers Company, in which that all-powerful official threatens the company with all manner of pains and penalties, unless it promises to desist immediately from its evil courses. The crime of the Boy Messengers Company is that it proposes to supply London with a corps of boy messengers, in conjunction with an electric call system, such as I believe is to be found in every large town in the United States. Unfortunately this scheme infringes the monopoly which the Post Office possesses of carrying letters and transmitting telegraphic messages. Aware of this fact, the directors of the Boy Messengers Company have for some time past been petitioning the Postmaster General to grant them a license. This he has persistently refused to do, and rather than permit such a useful service to be carried out by private enterprise, he now announces that the Post Office proposes to inaugurate an express service of letters. Even if this express service is really such it remains to be seen whether the state proposes, as does the messenger company, to provide depots all over London, where by pressing a button an errand boy, a cab, or a policeman can be obtained at a moment's notice. Up to the present the state has shown itself more efficient in dealing with the infinitely great than with the infinitely little, and it is to be feared that the machinery of the Post Office will hardly prove flexible enough to carry out such microscopic but useful duties as are performed by the messenger company.

The London Paris Telephone Line.—The cable across the English Channel from Sangatte, near Calais, to St. Margaret's

Bay, near Dover, in connection with the London Paris telephone trunk wire was finally laid late on Saturday e ening March 14. For nearly a week her majesty's telegraph steamer "Monarch" had laid off the French coast, waiting for a favorable opportunity to land the shore end and pay out the intermediate. On Monday morning, the 9th, the weather being favorable, the shore end was landed and the "Monarch" began to steam across the channel. When about midway a violent snowstorm came on suddenly, and being unable to see any distance ahead the captain of the "Monarch" let go her anchor at 4 o'clock in the afternoon. A 5 P. M. the weather cleared up slightly and it was discovered that the ship was lying right off St. Margaret's Bay, about a mile from the shore. An attempt was now made to lift the anchor and pay out the remainder of the cable, but the strong tide, aided by the wind, had driven the cable foul of the anchor, and after several fruitless attempts to clear, the anchor was slipped, the cable buoyed and the "Monarch" ran for shelter. On Thursday, the weather having moderated somewhat, an attempt was made to complete the operation of laying, but the cable had coiled itself several times round the anchor, and it was found necessary to cut the tangled portion away. This having been done, the "Monarch" was again obliged to run for shelter. On Saturday morning the weather was once more favorable and the cable was picked up five miles, relaid, and the shore end finally connected at a little after six o'clock in the evening. The electricians in the cable hut immediately called up the General Post Office in London, where three cheers were given, which resounded so lustily at St. Margaret's Bay that those in charge declared that the drum of the telephone had been split. A telegraphic message was then sent across the channel. On Tuesday, March 17, the Postmaster General and M. Jules Roche, the French Minister of Commerce, exchanged complimentary messages, and to-day representatives of the London and Paris press did the same. Judging from my own conversation with a personal friend in Paris whose voice I could distinctly recognize, the line leaves nothing to be desired. From London to Dover, a distance of 85 miles, the best copper wire, weighing 400 pounds to the mile, has been employed, and great care has been taken to insure good insulation and diminish induction effects. How successful the Post Office officials have been in respect to the latter is evidenced by the fact that a Wheatstone automatic transmitter working full speed on *one* of the telephone circuits could only just be heard on the telephone connected up to the other circuit. The French land line, which is nearly 200 miles long, is composed of copper wire weighing 600 pounds to the mile. The telephonic apparatus employed on their side is of the D'Arsonval type, that on ours being of the Gowen-Bell pattern. The K × R of the line is estimated at 5,300. The charge for three minutes' conversation will probably be ten francs and the line will be open to the public soon after Easter.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Incandescent Lamps on Arc Circuits.—Can I run three incandescent lamps of 50 volts on an arc circuit? If so, will I need to have a resistance coil, so that the 18-ampère current will not burn them out? What sized wire should I use for the coil, and how much of it? P. H. H.

We would not advise you to try running lamps in the way you suggest. You would do better to get the regular lamps intended for burning in series on arc circuits, running two or three of them on parallel in case you cannot get one to take an 18-ampère current. You will then need no external resistance, and will consume less energy for the same amount of light.

Telephone Induction Coils.—Will you kindly inform me through your columns: (1) What is the resistance of primary and secondary coils in a standard telephone induction coil? (2) Is the same size used in long distance work? What resistance will be correct for a telephone receiver for a line of 300 feet? SUBSCRIBER.

(1) Resistance of primary coil, 2½ ohms (No. 19 wire, B. & S.) Resistance of secondary coil, 260 ohms (No. 32 wire, B. & S.) (2) The coil for long distance work is proportionately the same. (3) A receiver of the following proportions will answer: Magnet core to be of tool steel (not Stub), 6¼ inches long and ⅛ inch in diameter; bobbin or coil to be of No. 30 (B. & S.) wire, and wound to 80 ohms.

Alternating Motors.—In THE ELECTRICAL WORLD of March 21, I find a description of a 100 h. p. alternating generator and motor, and it is stated that a 10 h. p. Tesla motor goes with the outfit to act as a starter for the large motor. What starts the Tesla motor, and if it is self starting why cannot the 100 h. p. motor be made to start itself in a like manner? J. C. D.

In its present form the Westinghouse motor manufactured on Mr. Tesla's plan is not so efficient as the synchronizing motor of the same manufacture; if it were it could be, and would be, used directly. As it is a self-starting motor it is used to work the larger machine up to synchronism, and its efficiency makes no particular difference.

Water Power Plants.—Will you please answer the following questions: 1. Can turbine water wheels be used satisfactorily to drive an incandescent lighting dynamo? 2. Can an arc dynamo be operated successfully by the same motive power? 3. Is there need for special governing apparatus? E. R. C.

1. There are numbers of electric light plants now in successful operation wherein turbine wheels are used. 2. Yes. 3. As a general thing, water power with the turbine gives a steady motive power, and no governor, aside from water-gates, is needed. The Sterling (Ill.) Electric Light Company, which uses turbines for both arc and incandescent light dynamos, can give you its experience in this line of operation.

Impedance vs. Resistance.—Can incandescent lamps be burned by means of an impedance coil without loss of energy occasioned by resistance? Suppose we have a pair of constant potential alternating motors carrying incandescent lamps, taking one ampère each at 50 volts; we wish to pass but one-half ampère through one lamp, thus dimming it. Does it matter whether we do this with an impedance coil or a resistance coil? Are we not using 25 watts in either case? SUBSCRIBER.

If you use the impedance coil you use simply the energy consumed in the lamp plus a very small amount lost in the impedance coil. If, however, you try to do the same thing by inserting your resistance, you use the same amount of energy in the lamp as before, but lose outright all that is due to the resistance concerned. The difference in the two cases is that between resistance and counter electromotive force. In the first case the effective electromotive force between the mains is reduced by inserting an ampère coil. In the second case the electromotive force is allowed to act, and part of the energy is absorbed in the resistance.

Static Electricity from Belts.—(1) Could the electricity generated by a large belt traveling at considerable speed be practically utilized to light gas throughout a large mill? (2) Is there any device for collecting electricity generated by belts? (3) Is it possible to store electricity generated as above, and, if so, where can a storage battery be obtained, so that gas might be lighted after machinery has stopped? (4) Is current greatest on belt midway between pulleys? Y. O. J.

(1) It requires the utmost care, together with glass tube insulation in many places, to carry the static charge to any distance, and while it is possible to do as you suggest, we are of the opinion that you would find in the scheme many difficulties. (2 and 3) A battery of Leyden jars will collect static electricity if collecting teeth are placed near the source, and if the outer coating of the jars is connected to earth. (4) You cannot speak of the static charge upon the belt as a current. It is reasonable to suppose that the charge is of higher potential at the centre of the dry belt, where it is not near a "ground," than at the pulleys where there is liability of leakage to earth.

Operation of Waterhouse Dynamos.—Will you kindly inform us if it makes any difference in which direction Waterhouse arc dynamo armatures are wound? They are of the Manchester type, series wound. Suppose the armature should be wound the opposite direction to that designed, what effect would it have, and would it make any material difference in operating, providing the field wires were connected reverse or opposite? E. G. S.

It will make no difference in which direction the armature is wound. It would only mean that, with a given relation to pole signs and a given direction of rotation, two oppositely wound armatures would have relatively opposite currents, and this will not affect the action of the Waterhouse regulator. You must remember, however, that, since the poles are reversed, the arc lamps, in order to have the positive pole connected to the upper carbon, will have to be placed in the circuit in the opposite way from that shown on the standard diagrams. The field connections should be reversed if the direction of armature rotation is changed, but not so if the only departure from the standard is in the winding of the armature as mentioned.

Lighting by Primary Battery.—Can you give me some information for constructing a chemical battery of sufficient voltage to light one or two incandescent lamps of 10 or 12 c. p. three or four hours per night for home use, or there is a simple battery manufactured for the above purpose? G. D. S.

Our general advice to those who think of undertaking to produce electric light, even on a small scale, from primary batteries is—Don't. You can get the light, but it is somewhat costly and troublesome unless you are familiar with the management of batteries. Those most generally used for this purpose are modified Bunsen batteries, consisting of a jar containing a zinc plate, or cylinder, immersed in dilute sulphuric acid, and a porous cell containing a depolarizing solution, generally composed of bichromate of potash and sulphuric acid, in which a carbon plate is plunged. Both zinc and carbon plates should be large, in order to expose a considerable surface and to reduce the internal resistance. A good depolarizing liquid is composed of 45 parts water, 15 parts sulphuric acid, and five parts of bichromate of potash, by weight. The bichromate should be dissolved in the water, and the sulphuric acid added very slowly, with constant stirring. If you desire to buy batteries, look through our advertising columns, where there will always be found one or more batteries suited for small lights.

Field Magnet Winding.—I have a small shunt-wound motor which I wish to use on a 110-volt circuit. I find that the resistance of the field is too small, and I have been advised to rewind the armature with finer wire. Can I benefit the machine by so doing? Could an outside resistance in series with the field resistance be used with any fair result, or must I rewind? How can I compute the resistance of an armature from the wire that is put upon it? E. W. D.

From what you say we would judge that your motor was intended for a voltage considerably below 110. If you want to use it on a circuit of that potential you could insert an exterior resistance sufficient to cut down the voltage to that for which the motor was intended, or you can reconstruct the motor for 110 volts. You will get a rather better output from the motor by the latter proceeding, but it is much more trouble. It is difficult to tell which plan would be the more advantageous without knowing the voltage for which your machine was designed. The resistance of the armature measured from brush to brush is one-fourth the resistance of the total length of wire wound on it. This is true for every closed coil armature, whether of ring or drum type. The reason for it is plain. The two halves of the armature are in parallel, and consequently the total resistance is that of two wires having half the total length of the armature winding placed in parallel. In other words, the resistance is half that of either of them taken singly.

News of the Week.

THE TELEGRAPH.

Mr. J. W. Mackay was elected president of the Commercial Cable Company last week. Other officers chosen were: Vice-Presidents, G. G. Ward, C. R. Hosmer, and A. B. Chandler; treasurer, E. C. Platt; secretary, J. O. Stevens.

London Telegraph Messages.—Postmaster General Raikes has informally told the London messenger companies that, after having gained his case against them in the courts for infringing the government monopoly, he will grant them a license to carry messages, receiving a government royalty of one-half penny on each message carried and thus protecting the post office and public revenue against competition.

THE ELECTRIC LIGHT.

Tuscola, Ill.—The electric light plant was started for the first time last week.

Ridley Park, Pa.—A resolution authorizing the introduction of electric lights was adopted last week by the local council.

Portland, Ore., has called for bids for street lighting for two years. The specifications call for 100 arc lights of 2,000 c. p., and 800 incandescent lights of 25 c. p.

Gallatin, Tenn.—A bill has been introduced in the Legislature authorizing the issuance of $10,000 of bonds for street improvement, also empowering the town to borrow $10,000 for electric lighting.

Monterey (Cal.) Electric Light and Development Company has closed a contract with the Edison Company for a central station plant, to supply Monterey and Pacific Grove with lights. A 540 incandescent plant is to be in operation in 45 days.

Pittsburgh, Pa.—The department of public works has just completed arrangements for an addition to the arc lighting of the city's streets. At the present time 900 arc lamps are employed for this purpose and an increase of 160 lights is to be made. These lights will be used in the South Side district, which heretofore has not been as well illuminated as other parts of the town.

Newcastle, Australia.—The Westinghouse Electric and Manufacturing Company has installed an electric light plant in the above city. The station comprises arc and incandescent machinery of the alternating current type run by Westinghouse compound engines. The boilers are of Messrs. Babcock & Wilcox manufacture. The people of the city are extremely well pleased with the new light.

The Montreal Convention of the N. E. L. A.—Copies of the Montreal *Star*, *Gazette* and *Herald* of last week all contain information regarding the preparations now being made for the midsummer convention in Montreal. Mr. Corriveau, who was in New York last week looking after the interests of the convention, ably seconded by the press of his city, is doing all in his power to make the coming convention one of profit alike to the members of the association and the Canadian people. The hospitality of McGill University has been extended by Sir William Dawson, the principal, and an invitation has already been received from the Quebec and Levis Electric Light Company to visit Quebec and inspect the water-power electric plant of that company.

Plant on the Prince of Monaco's Yacht.—The electric lighting of H. R. H. the Prince of Monaco's yacht "Princess Alice" has been placed in the hands of Woodhouse & Rawson United (Limited), electrical and mechanical engineers, 88 Queen Victoria street, London, E. C. The engine is to be of the single cylinder vertical type running at from 200 to 250 revolutions, with a steam pressure of 150 pounds, and is provided with an extended bed plate for receiving the dynamo, which is coupled direct to the engine, and gives current for 100 16 c. p. lamps at an E. M. F. of 135 volts, this particular E. M. F. being provided to allow of charging the accumulators. The full number of lamps will be installed throughout the yacht, and the fittings will be of an elaborate description, and designed specially for this installation. The whole of the arrangements are not yet completed, but in all probability there will be provided a set of accumulators, a projector, and also a powerful submarine arc lamp for carrying on scientific observations at night.

Large Isolated Plant.—Mr. Charles H. Davis, of 120 Broadway, has just completed the installation of an isolated plant of 1,200 lights capacity in the dry goods store of Messrs. H. C. F. Koch & Co., of New York City. The current is supplied by two Thomson-Houston compound wound dynamos, one of 800 lights and one of 400 lights capacity. Each machine is driven by an independent high-speed "Ideal" engine of 80 and 40 h. p. respectively, which, with a separate circuit to every floor, insures light to the building at all times. The main switchboard is located in the dynamo room, and is so arranged as to allow the machines to operate together or alone on any or all circuits. It is made of enameled slate, and has the voltmeters, ammeters, rheostats, switches, etc., arranged in a most artistic manner. The basement has 136 lights, and the first floor is lighted by 246 ground glass lamps, placed on beautiful fixtures arranged in seven long rows the length of the store. The lights in the show windows are placed against the ceiling, with 12-inch double glass reflectors for each light. There are ten lights to each window, forty in all. These reflectors are the feature of the show-window lighting, being made of glass front and back, the space between filled with a mercury compound and hermetically sealed. They never tarnish, are extremely bright, and with ground glass lamps reflect a powerful but soft light. These reflectors are manufactured by the Thackera Manufacturing Company, of Philadelphia. The second floor is lighted by 216 lamps, all on fixtures, as on the floor below, except a few reflectors in fitting rooms and other dark places. The lamps on the third floor, 200 in number, are mostly on fixtures, while on the fourth floor 200 silk drops are used, the wiring being on insulators and all exposed. In this plant there are 172 ceiling fixtures, 265 silk cord drops, 41 receptacles, 57 reflector lights, four newel fixtures, and three bracket fixtures, or a total of 542 outlets and 1,007 16-c. p. lamps.

THE ELECTRIC RAILWAY.

Oakland, Cal.—The ordinance granting an electric franchise to Henry W. Meek, C. E. Palmer and others, upon certain streets from the eastern line of the city to Broadway, was adopted last week.

The Braddock (Pa.) Street Railway Company has begun work upon its power house, which is situated at Rankin, one of the suburbs of Braddock. The work will be completed by June, and it is expected that the line will be ready for operation not long after that time. Judging from the topography of Braddock, it being a long and narrow town, a street railway in it will prove a paying investment.

West Haven, Conn.—Mr. S. H. Sale, of the Detroit Electrical Works, has been engaged for several months at the machine shops of Messrs. H. S. Thompson & Sons carrying out a test of a car equipped with the new arrangement of the Shewhan system, wherein, instead of gear connection, an endless chain is used. The Detroit Company furnishes the battery. The car has given perfect satisfaction so far, and next week a car will be run over the Fair Haven road.

Davenport, Rock Island (Ill.) and Moline Electric Railway.—It is expected that the electric cars will be running on the Rock Island side of the river within three weeks. There is now in the power house in Rock Island enough machinery to operate a portion of the system, and things are only waiting on the completion of one of the three large tripod boilers which are to furnish steam for the engines. The car shop in Davenport is under roof, and its inside work will be finished in two weeks, when it will be ready for occupancy.

The Consolidated City Street Railways, of Kansas City, Mo., an electric road connecting the two sides of the city, made its trial trip recently, which was in every way a successful one. The trip was made under the direction of the Thomson-Houston Electric Company, which firm furnished all of the electrical equipment of the new road. This line connects with the elevated system and the Grand View road, and passes the doors of many large manufacturing plants employing thousands of men, who will gladly avail themselves of the cheap and rapid transit afforded by the new electric line.

PERSONALS.

Mr. Edward Heaton, an electrician of Tampa, Fla., was married last month to Miss Alta Holmes, of that place. Mr. and Mrs. Heaton will make their home in New York City.

Mr. Chas. A. Matcham has resigned his position as superintendent of the Lancaster division of the Pennsylvania Telephone Company after an engagement of eight years. He has accepted a position with the Bell Telephone Company of Philadelphia.

Mr. Herman W. Grannis, of the railway department of the Westinghouse Electric and Manufacturing Company, attended a meeting of the Jersey City Board of Trade on Monday evening of last week, and in an address to the board presented his views on the adaptability of the trolley system to the street railways of Jersey City. He carefully reviewed in a clear and interesting man-

ner all of its advantages and its alleged disadvantages, and answered at the close of his address a number of questions asked by various members of the board.

LEGAL NOTES.

Wisconsin Telephones.—The Wisconsin Senate has passed a bill requiring telephone companies to pay an annual license fee of 2¼ per cent. on their gross earnings.

Bell Company vs. the Government.—Counsel for the government in the case against the American Bell Telephone Company in Boston has been given three months' extension of time in which to introduce testimony before the examiner appointed by the United States District Court.

MISCELLANEOUS NOTES.

A Bohemian Centennial Exhibition will be held at Prague, in Bohemia, from May to October, 1891, and American inventors are especially requested to be present and display such of their goods as will find a market in that section.

Air Ship.—It is reported that Messrs. Siemens & Halske have undertaken the electrical apparatus for an airship which is to be exhibited at the Frankfort Exhibition in the shape of a large dirigible balloon for carrying 10 persons. The balloon will have a telephone connection, and the gas will be generated by electrolysis, the arrangements being suitable for war balloons.

The Recent Discovery of Natural Gas in England.—In his lectures on "Gaseous Fuel" (since published by Messrs. Whittaker & Co., London) Mr. Thwaite gave it as his opinion that beneath the salt beds of Cleveland, Cheshire and Ireland both natural gas and oil would be found. At Mr. Verdin's request, according to *Industries*, London, Mr. Thwaite elaborated his theory, which was in due course submitted to the Salt Union, with the result that the Salt Union decided to put the theory to the test of the drill, and borings have been proceeding simultaneously in Cleveland and Cheshire. It is reported that in the former district natural gas has been struck and issues in great volumes. The discovery is of great national importance, as it may mean the conferring by nature on Cleveland of all the natural advantages possessed by the great iron centre of Pittsburgh and district, and prove of enormous advantage to the metallurgic and chemical industries carried on in the North Yorkshire iron field. It is hoped that the test in Cheshire may be equally satisfactory, and thus confirm to the full Mr. Thwaite's predictions.

Electrical Progress in Costa Rica.—A correspondent sends us the following from his home in Central America: "In the city of San Jose, the capital of the Republic, a Thomson-Houston arc-light plant of 100 lamps of 1,200 c. p. each is now in operation, This plant only runs on those nights that the moon fails to put in an appearance. This company has commenced work on the electric tramway, grading the road and building its power house, which is about 3,000 feet from the nearest point of the line of the road. This electric line is to be about six miles in length, single track, and is to have two branches. At first there will be six motor cars and six tow cars, as well as four flat cars to be towed from the Sabana to the freight depot and Custom House, carrying coffee to the Custom House and freight to the city. The Sabana is a point where races and picnics are held. Two waterfalls are accessible; one is a 160-foot fall, with 1,600 cubic feet per minute, and the other is a 94-foot fall, with 3,8 0 feet per minute, which will give about 800 h. p. Two alternating current dynamos of 750 lights capacity are to be put in. The system to be used is not yet decided upon."

Industrial and Trade Notes.

The Gibbon Duplex Track Company is making estimates for a number of street railways, and the spring outlook is good.

Wm. Baragwanath & Son have in preparation a power boiler feed pump, which is said to be a step in advance of anything in this line now on the market.

The Insulite Company, manufacturers of the insulite lamp socket, the invention of Mr. Thomas G. Roebuck, has received many testimonial letters praising this socket.

The Jewell Belting Company, of Hartford, Conn., has just placed two of its 40-inch double belts in the power plant of the Johnson City, Tenn., Electric Light and Power Company. The Jewell Company is very busy with orders.

The Globe Street Railway Company, of Fall River, Mass., has been purchased by the syndicate which owns the Rochester, Buffalo and Bridgeport roads. The above road has in operation 18 miles of line, which will be changed to the electric system at an early date.

An Easter Egg was sent out by the Mason Regulator Co. to its patrons. The egg, neatly packed, bears the label, "A Fresh Egg; Crack it and See," and upon being cracked a little circular is found, which calls attention in an amusing way to the merits of the company's specialties.

Messrs. Herkner & Stine, of 8 Ferry street, New York City manufacturers of a superior quality of oak-tanned leather belting, have furnished a large number of plants with their "electric light" belting, the most recent installment being in the electric light plant of the World building in this city.

The Triumph Compound Engine Company, of Cincinnati, O., formed some time ago to manufacture the efficient compound of Mr. J. H. Eickershoff, is now doing a large business with the "Triumph" engines. These engines are specified in several contracts in Chicago, Ill., which are to be let at an early date.

The Carr Metal Company, of Fall River, Mass., has appointed the Great Western Electric Supply Company, of Chicago, its general Western agent. The business of the Carr Metal Company is increasing rapidly. The zincs manufactured by this company are of an alloy of zinc and mercury, the invention of this company.

The Engineering Equipment Company, of 73 Cortlandt street, New York, is prepared to furnish Habirshaw wire, in certain sizes, in moderate quantities, by way of accommodation. This company's trade in Underwood cotton leather belting is increasing daily, as is also its other specialties. The company removes to its new offices April 1.

The Dixon Crucible Company, of Jersey City, N. J., has long made a study of the manufacture of graphite or plumbago, and being the only company in America which operates its own mines is in position to give advice to consumers. Upon application this company will send a small book which contains much information regarding graphite.

The Royal Electrical Specialty Company, of 239 Water street, New York City, manufacture a practical form of glass floor insulator. The objection to most forms of these insulators is that they are too short and that the flange is too flat on the floor, thus allowing water to run down along the wire. This insulator has none of these objections.

The Sunbeam Incandescent Lamp continues one of the important specialties of The Electrical Supply Company, Chicago. It does not aim simply at length of life, nor is it a lamp of merely high efficiency. It is intended to strike that mean in life and efficiency at which, all things considered, the most light is returned for each dollar of expenditure in current.

The Backus Water Motor Company, of Newark, N. J., has just been granted a patent for a special high grade rotating fan. One of these at the works, made up of bird's-eye maple blades and base, with nickel attachments, is a very attractive exhibit. This company also manufactures fans with a mirror column, bases showing mirrors in the sides which are very beautiful.

The Hunt Engineering Company, of Brooklyn, has closed a contract for a 50 arc light plant and a 1,000 incandescent plant for the town of Manistee, Mich.; also a 25 arc light plant for the Weston Furnace Company, of the same place. Mr. Wm. Fay, well known in the electrical business, will hereafter control the western territory for this company's specialties, with headquarters at Elgin, Ill.

Mr. R. I. White, the well-known manufacturer of street railway rails and track-fittings, has established the following agencies: Mr. W. D. Thomas, 141 Bryan street, Savannah, Ga.; Messrs. D. E. Garrison & Co., Laclede Building, St. Louis, Mo., and the Great Western Electric Supply Company, 190 and 192 Fifth avenue, Chicago, Ill. Mr. White has been doing large business, supplying electric railroad systems.

A Quick Break Switch.—The Hunt Engineering Company, of 238 Washington street, Brooklyn, has just offered the trade its new single pole, 200 ampère, quick break switch. This switch has a fuse and feeder connection. This company will have completed on June 1 a new catalogue showing a full line of branch blocks cut-outs, snap and feeder switches, sockets, etc. The catalogue will be unique in design, and, judging from the prospectus, will be most elaborate.

The Page Belting Company has gotten out a catalogue of leather and rubber belting which contains, in addition to descriptions and price lists of the company's belting, a number of practical rules for the purchase and use of belting. Some instructions are also given regarding the best kinds and grades of belting to use for different sorts of work. The pamphlet, which contains 52 pages, has a supplement giving information concerning various modes of belt driving.

Messrs. Nalder Brothers & Co., of 16 Red Lion street, Clerkenwell, London, E. C., send us a catalogue of their electrical and scientific instruments. This company carries a most complete and large stock of all types of electrical measuring instruments, besides many other scientific instruments. Mr. Francis H. Nalder, of this firm, is on a visit in the United States, and is now in New York City preparing for the establishment of a manufactory of electrical measuring and test instruments.

Mr. Samuel T. Williams, engineer and machinist, of 447 North street, Baltimore, Md., is soon to put upon the market an engine embodying some new ideas in compounding, which, it is claimed, will make the well-known engine even better than it has been heretofore. The Williams engine has always stood in the very front rank, as is attested by the numbers of commendatory letters received by Mr. Williams. This firm will soon move into new quarters, where the Williams engines will be manufactured exclusively.

The Pittsburgh Reduction Company has just favored us with a fine specimen of the purest aluminium of its manufacture. It is stated on analysis to contain but .07 of a per cent. of impurity. This is the purest the company has ever made, although a considerable amount of their output is over 99½ pure. The particular specimen received gives every sign of being unusually pure metal. Especially noticeable is the almost entire absence of metallic odor on handling and rubbing that is freely developed in impure aluminium.

Messrs. Jeffers & Kumberger, agents for the White & Middleton gas engine, one of which was illustrated in a recent issue of THE ELECTRICAL WORLD, have removed from 404 Canal street to more commodious quarters at 158 West Broadway, where they have their engines on exhibition. Their facilities for manufacturing are being increased, and they will soon be prepared to furnish any number of engines promptly. This company makes a specialty of gas engines designed for electric light and power plants, having heavy balance wheels and automatic governor.

The Grady Electric Alarm Clock.—Messrs. T. H. Grady & Co., of 263 Fulton street, Brooklyn, have recently brought out a convenient form of electric alarm clock. The difficulty with most forms of electric alarm clocks has been that the contact point holds back the hand, thus interfering at each alarm with the time setting; but Mr. Grady has overcome this objection by having an additional contact hand which can remain behind continuously, ringing the alarm without interfering with the running of the clock. The Grady clock can be used as an office call bell.

Messrs. W. R. Fleming & Co., New York agents for the Foundry and Machine Company, of Harrisburg, Pa., builders of "Ide" and "Ideal" engines, are doing an excellent class of work for steamships, etc., as well as in other lines of electric steam power work. They have just taken orders for engines for running dynamos on two of the United States government lightships on Staten Island, and also for the Pacific Mail Steamship Company. Messrs. Fleming & Co. are starting up some three or four large plants in and around New York City this week, which they have contracted for. This company is building up a fine business in this line of work.

The Snow Steam Pump Works, of Buffalo, N. Y., is opening large and commodious warerooms in New York at 116 Liberty street, with Mr. J. Brotherhood as manager. This company manufactures improved pumping machinery, chiefly of the duplex pattern. The valve motion is simple and perfect in design. The Snow "duplex plunger" pump, for general use, is fitted with iron plunger and brass rings. The Snow pumps are all double acting and fitted with rubber valves, brass seats, guards and springs, suitable for pumping cold water. This company was organized in Buffalo, in January, 1890, and the trade already secured has been very large.

Awarded a Medal and Premium.—The committee appointed by the Franklin Institute of Philadelphia to examine the interior conduit system of the Interior Conduit and Insulation Company, of this city, has recommended the award of the John Scott legacy medal and premium to the inventor Mr. E. H. Johnson. The committee was composed of Carl Hering, T. Carpenter Smith, Richard W. Davids, E. A. Scott and Wm. McDevitt. A paper read before the institute early in the winter appears in the last number of the Journal of the Franklin Institute, and is a very clear and detailed description of the conduit system as now put into actual service in a very large number of installations.

The Detroit Motor Company has just gotten out a new catalogue which illustrates very fully the different types of motors and dynamos manufactured by this company. Illustrations and descriptions are given of constant potential and constant current motors, and tables of the horse power required for various classes of work to which motors are applied. It also contains a large number of tables which give the weight, length, resistance, etc., of copper wires. A chapter is also devoted to water power and its use in the generation of electricity by the means of dynamos. Messrs. Hatzel & Buehler, of New York City, have been appointed New York agents for this company's apparatus.

The Simplex Electrical Company, of 620 Atlantic avenue, Boston, Mass., has issued a very complete little book called "The Simplex Manual of Valuable Tables and Formulæ," which is designed for the use of electrical engineers. It contains a great deal of information regarding the resistance of copper wires, the comparison of wire gauges, the formulæ and data for the calculation of wiring for electric light, together with the price lists of Simplex specialties, such as "T Z R" wire submarine cables, Simplex insulating paint, etc. A large number of letters are also given which the Simplex Company has received from its patrons. All of them speak very highly of the efficiency and durability of the Simplex wires.

The Westinghouse Machine Company, of Pittsburgh, Pa., whose business consists in making and selling, through the medium of its agents in every part of the civilized world, its well-known Westinghouse engines, has had no financial difficulty, as might be expected from the recent trouble in some of the allied interests. Instead of curtailing its operations, this company is still further increasing its capacity as rapidly as it can. New tool and store rooms are just approaching completion, and it is hoped by the management, during the coming spring or summer, to be able to add complete new erecting and testing shops fitted with large power cranes and all modern improvements, and which shops will have a producing capacity twice as great as the present ones.

The Partrick & Carter Company, of Philadelphia, has just issued and is sending to its patrons a very handsome catalogue of its specialties. These include almost every variety of apparatus used in the electrical trades, beginning with annunciators and ending with zincs. Among the new things which will be noticed in the catalogue is the King annunciator, which is illustrated elsewhere in this issue. The catalogue has been prepared especially for the trade and the company will probably be glad to furnish a copy of it to any applicant who is a dealer in electrical supplies. It is of interest to notice that this company gets up a sample show-board, which contains 17 distinct pieces of apparatus, intended to show not only the construction but the operation of a number of the company's devices, among them being annunciators, bells, push buttons, switches, door springs, etc. The board is of hard wood and is 15 × 22 inches in size.

The Interior Conduit and Insulation Company, 16 and 18 Broad street, this city, has issued the following announcement regarding the extension of its business and the acquisition of increased facilities: "It has been deemed advisable by the Board of Trustees of the Interior Conduit and Insulating Company to largely extend the scope of its business by the acquisition of facilities to enable it to engage in a general manufacturing business. This has been made apparent by the demands of the company's customers for all kinds of appliances not now manufactured by it, and the fertility of the practical men identified with the Conduit Company and with the Bergmann Electric and Gas Fixture Company in the matter of developing new electrical and mechanical appliances, for which the market is broadening and expanding in a most remarkable manner. It was a realization of the fact that there is enough business of this character in sight to keep a large factory fully and profitably employed which induced the board of trustees to secure an option from the Bergmann Electric and Gas Fixture Company for the purchase of the entire real estate, factory buildings, machinery, tools, plant, good will and business belonging to the latter company at a price which equals the net cost of the property to the said Bergmann Electric and Gas Fixture Company. Inasmuch as this factory immediately adjoins the present plant of the Conduit Company, the advantages of such purchase are self-evident. The two factories can be united and operated as one with practically no additional expenditure of money. The following is a short statement of business in sight for the new factory, viz: 1st. An established and steadily growing interior conduit trade. 2d. Negotiations pending with several large street railway companies for underground conduits for their wires. 3d. An established manufacturing business (the Bergmann shop), now engaged in doing work for the Western Union Telegraph Company and other outside electrical concerns, also doing a considerable amount of work for the Conduit Company. 4th. The immediate manufacture of a considerable number of the inventions. 5th. Manufacturing rights under electric railway patents, which have been allowed and will shortly issue, covering a principle practically applied, which is not only far superior to any existing methods, but so much so as to provide an immediate solution of the elevated railway problem. As an additional advantage to the consolidated company, Mr. E. H. Johnson has agreed to execute an option to it on his new electric railway and other patents. This option may, or may not, be availed of by the company as the judgment of its Board of Trustees may determine, after a practical trial and demonstration of the merits of the inventions. In order to avail themselves of the opportunities thus offered, and obtain the requisite capital to conduct its present rapidly developing business, together with the large increase thereof to be secured by the arrangement herein stated, the Board of Trustees of the Conduit company have concluded to offer for sale the balance of their treasury stock, now in the hands of E. W. Little, trustee. The stock in question, amounting to 3,071⅓ shares, is held for the benefit of the company, and subject to disposition as directed by the Board of Trustees. This stock has once been issued at par and thus made non-assessable; it is, therefore, now subject to disposal at any price that may seem best to the Board, and is thus available to meet the necessities for just such an opportunity as is offered the company at the present time. Three thousand shares of this stock are offered to the stockholders and to the public generally for sale at $75 per share, until Saturday, April 4, 1891, at noon. A syndicate has been formed, which guarantees to take at $75 per share all amounts unsubscribed at that date." The company will have at the outset about 40 patents on various apparatus of an electrical character. Of the $220,000 realized by the sale of stock, about $95,000 is to be used for the purchase of the Bergmann Company's business, leaving about $135,000 for working capital and to be applied to the retirement of floating debts.

Business Notice.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MARCH 24, 1891.

448,644. Electric Converter; Moses G. Farmer, of Eliot Me. Application filed Oct. 11, 1890. A core for an electrical con verter or inductorium, composed of laminæ of tinned iron with laminæ of non-magnetic metal interposed between them. (See illustration.)

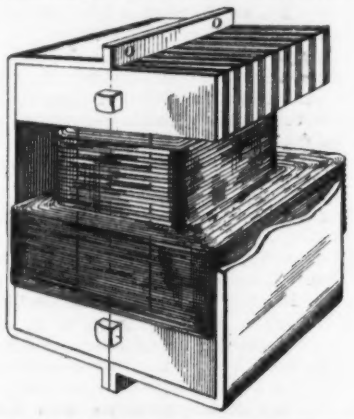
448,653. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa , Assignor to the Electric Car Company of America' of same place. Application filed March 24, 1887. The combination, with the sectional conductor, of two or more electric locomotives, each bridging a break in said conductor, and rotary horizon ally swinging switches controlling connection between sections of said conductors and adapted to be operated by the said locomotives.

448,666. Dynamo Electric Machine; Samuel E. Nutting, of Chicago, Ill., Assignor to the Nutting Electric Manufacturing Company, of same place. Application filed May 13, 1890. The combination of a field iron, consisting of a hub and four cores for field coils projecting radially at right angles to each other from the hub and in the same plane, polar extensions projecting from the outer ends of the cores at right angles with their plane, and an armature adapted to rotate within a circle partly inclosed by the polar extensions and in a plane parallel to the plane of the cores.

448,669. Electric Contact Device; Frank A. Perret, of Brooklyn, N. Y., Assignor to the Elektron Manufacturing Company, of same place. Application filed June 28, 1890. The invention consists of a base of holder provided with chambers, in which are loosely placed pencils or blocks of carbon, in combination with springs arranged to act independently upon the respective carbon pencils to force them towards the surface against which it is to make a working contact. The pencils are easily removable from the block whenever it is desired to replace them for any purpose. (See illustration.)

448,676. Meter for Alternating Electric Currents; Oliver B. Shallenberger, of Rochester, N. Y., Assignor by mesne assignments to the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa. Application filed March 13, 1890. The combination with an alternating current electric circuit, of a meter having a primary coil, a secondary coil placed at an angle therewith, and a rotating armature acted upon by the inductive influence of the currents traversing said coils, said armature having dead points.

448,677. Meter for Alternating Electric Currents; Oliver B. Shallenberger, of Rochester, N. Y., Assignor by mesne assignments to the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa. Application filed March 13, 1890. The



No. 448,644.—ELECTRIC CONVERTER.

combination with a meter for alternating currents, having a primary inducting-coil, a secondary coil in inductive relation thereto, and an armature acted upon by currents traversing the two coils, of a short-circuiting device applied to the primary inducting-coil and automatically operated by the currents traversing the circuit to which the meter is applied.

448,679. Waterproof Coupling and Cut-Out for Electric Circuits; Frank Shlaudeman, of Decatur, Ill. Application filed Nov. 3, 1890. The combination, with two sockets, the interposed gasket, and the coupling-bolts, of the cut-out cylinder having bearings in one of the two sockets, a gasket around the projecting end of the cylinder-shaft, a spring bearing against the cylinder and acting indirectly on the gasket thereof, and circuit-wire terminals bearing against the cylinder on opposite sides of the same.

448,680. Connector for Electric Wires; Frank Shlaudeman, of Decatur, Ill. Application filed Nov. 3, 1890. The invention consists in a joint of circuit composed of a water-proof pipe or casing and circuit wires in the case projected yieldingly beyond the ends thereof, so that when the ends of two such joints are coupled together the circuit wire terminals will be forced in close contact, those of one pipe with those of the other.

448,681. Speed Regulator for Electric Motors; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed Oct. 10, 1890. An electric motor having an adjustable rheostat and a speed branch composed of a resistance shunt on the field and switching means for said branch controlled by the means for adjusting the rheostat and arranged to send current through said branch when the rheostatic resistance is reduced or cut out.

448,682. Adjustable Rheostat; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed Nov. 15, 1890. An electrical resistance comprising a body of subdivided conducting material—like carbon powder, for example—held in an insulating casing, and metallic end plates in contact with the subdivided conducting material and provided with a number of conducting projections which penetrate said material, in combination with switching means.

448,684. Fire-Alarm Signal Box; Wm. F. Singer, of Carthage, Assignor to the Singer Fire-Alarm Company of Buffalo, Ltd., of Buffalo, N. Y. Application filed March 11, 1889. A fire-alarm system provided with a main and an auxiliary circuit, signal-boxes connected by both circuits, and a relay in each signal-box to automatically cut in the auxiliary circuit upon rupture of the main circuit.

448,698. Electric Switch; Donlee B. Turner, of Chicago, Ill. Application filed June 18, 1890. A switch having two elbow crank levers with suitable contacts for their long ends, a reciprocating piece connected with their short ends, and a lock having a movable part which controls the reciprocations of such piece.

448,703. Support for Electric Line Wires; Herbert C. Wirt, of Boston, Mass. Application filed March 17, 1890. The combination, in an electric railway, of an insulator and transverse supporting wire passing around the insulator, a clamp secured at its ends to the wire passing around the insulator, a clamp secured at its ends to the wire so that the insulator is surrounded and held between the wire and the clamp, and a line conductor suspended from the insulator.

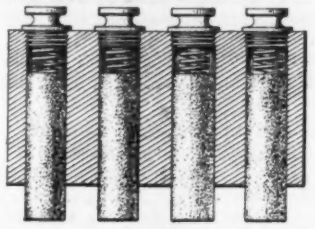
448,711. Overhead Crossing Appliance for Electric Railways; Isaiah H. Farnham, of Wellesley, Assignor to the New England Telephone and Telegraph Company, of Boston, Mass. Application filed Nov. 20, 1889. The combination of intersecting electric supply conductors for an electric railway, with one or more automatically operated conducting bridging sections therefor electrically connected with one of the said conductors, each bridge being a movable section of the upper trolley conductor, of suitable length and shape, hanging in the path of the traveling contact, which movable section is adapted to be struck by the said traveling contact and thereupon forced into a position to complete the track for the passage thereof, but acting at all other times by its own gravity to fall away from said track and to maintain the discontinuity of said trolley track.

448,726. Telephone Transmitter; Thornstein Oeyan, of Christiania, Norway. Application filed Oct. 25, 1890. In a phonic transmitter, a microphone-casing and a holder therefor connected together so as to revolve about their axis and to alternately recede from and approach each other when one of said parts is continuously revolved in the same direction, or when both parts are continuously revolved in opposite directions.

448,743. Electric Heater for Dental Vulcanizers; Jeremiah O'Meara, of New York. Application filed Oct. 22, 1890. The combination of a dental vulcanizer having a steam generator, a surrounding incombustible jacket, and an electric heating coil placed around said jacket, with an electric conductor, a plug to which it is attached, and leading-in or supply circuit wires provided with a socket with which the plug may be engaged.

448,751. Railway Circuit for Signaling and Controlling Trains; Frank E. Kinsman, of Plainfield, N. J. Application filed June 11, 1890. In an apparatus for controlling the movement of railway trains, the combination, with a controlling magnet in a normally charged circuit, and means for interrupting such charged circuit to set the apparatus in "danger" condition, of a supplemental magnet or magnet coil for keeping the apparatus in "danger" condition, and a circuit therefor independent of that used in setting the apparatus, said circuit being through the rails and car wheels and axles of a section of road upon which the train moves while the apparatus requires to remain in "danger" condition.

448,778. Electric Railway; Thomas A. Edison, of Menlo Park, N. J., Assignor to the Edison Electric Light Company, of New York. Application filed Aug. 7, 1882. In an electric railway,



No. 448,669.—ELECTRIC CONTACT DEVICE.

two main-line conductors, in combination with a source of electric energy therefor, and two branch line conductors connected to the main line conductors in permanent multiple-arc connection.

448,779. Telegraph; Thomas A. Edison, of Llewellyn Park, N. J. Application filed July 19, 1886. The combination with two or more telegraph lines, each having ordinary Morse sets and induction sets, of one or more retarding or damming magnets to divert the induction signals from portions of such lines.

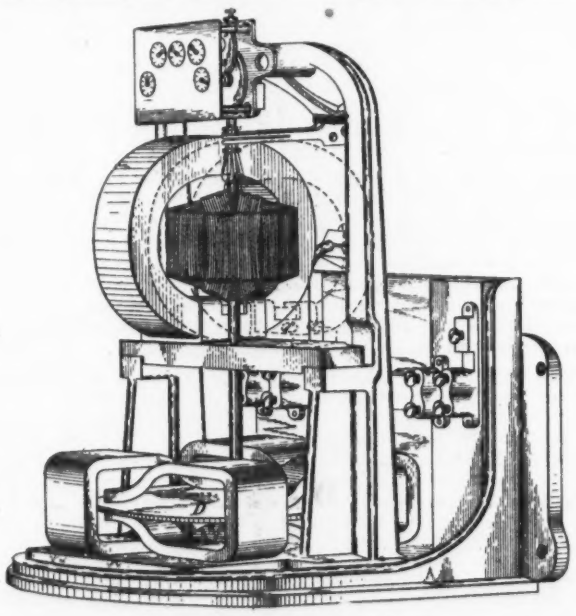
448,782. Electric Lighting; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Dec. 30, 1890. The combination of a line circuit, an electric lamp connected therein in series, a shunt circuit in the line circuit about said electric lamp, a heating coil arrangement in said shunt circuit, a receptacle having fixed terminals connecting with the line circuit, and an expansible fluid conducting substance in said receptacle adapted to be expanded upon an excessive current passing through the heating coil for the purpose of reducing the resistance to the passage of current in the line in case the lamp should burn out.

448,792. Electrical Indicator; Charles Wirt, of New York. Application filed May 2, 1887. An electrical indicator having a frame supporting an adjustable resistance and resistance coils secured to the bottom of said frame and constituting a fixed resistance co-operating with the adjustable resistance in said indicator.

448,798. Galvanic Battery; Charles J. Hirlimann, of Fort Lee, N. J. Application filed Nov. 26, 1890. A galvanic battery, comprising a porous vessel made of molded carbon and filled with manganese or other depolarizing agent, and having a concaved bottom, the said bottom being provided with perforations, whereby when the vessel is inserted into the solution the latter will be forced through the perforations into contact with the depolarizing agent and immediately render the battery active

448,831. Trolley for Electric Railways; Rudolf Eickemeyer, of Yonkers, N. Y. Application filed July, 1890. A trolley provided with a braking device, which by constantly acting on the wheels will cause the trolley to maintain a substantially uniform position with relation to the traveling motor.

448,838. Insulator for Electrical Conductors for Mines; Francis A. Pocock, of Scranton, Pa., Assignor of two-thirds to Elmer H. Lawall and Rufus J. Foster, both of same place. Application filed June 26, 1890. In the insulation of electrical conductors for the gangways of mines, the combination, with a conduit or casing having a longitudinal extension or rail for supporting the collector of the motor, of insulating blocks



No. 448,894.—ELECTRIC METER.

secured within the conduit or casing and supporting the main conductor or main feed wire, and flexible sheets which close an open side of the conduit or casing and permit the passage of the collector.

448,840. Protecting Motor Mechanism of Electric Cars; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed Nov. 15, 1890. A car-motor frame provided with a pan integral therewith.

448,847. Clamp for Electric Battery Zincs; Jas. H. Leakin, of Baltimore, Md. Application filed Dec. 24, 1890. In a clamp, the combination of a collar, a cam pivotally connected thereto, and an adjustment-screw extending through said collar and located in juxtaposition to said cam

448,856. Electric Signaling Apparatus for Railways; Edwin D. Graff, of New York. Application filed Sept. 29, 1890. A railway signal block system in which the locomotives are provided with bell circuits, the combination of suitable conductors extending continuously throughout the length of the block along the line of the railway, a switch forming a part or continuation of one of said conductors, means arranged within proximity to one of the rails adapted to be acted upon by one of said locomotives to move said switch to connect it with the other of said conductors and break the continuity of the conductor of which it forms a part, and means adapted also to be acted upon by said locomotive to subsequently disconnect said conductors and restore the switch to its initial position.

448,879. Electric Heating Apparatus; Mark M. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed Jan. 20, 1890. In an electric heating apparatus, a suitable metallic case, one or more resistances or heat developing electric conductors within said case and formed in layers, a fibrous refractory material in contact with and enveloping or covering the conductor or conductors, and means to maintain said material in close and constant contact with the said conductor or conductors.

448,894. Electric Meter. Elihu Thomson, of Swampscott, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Sept. 26, 1890. The combination, in an electric meter, of an electric motor, a register mechanism for counting the movements of said motor, and a commutator for said motor, having both its moving and stationary conducting surfaces made of pure silver. (See illustration.)

448,910. Electric Street Car Driving Gear; Conrad M. Conradson, of Madison, Wis. Application filed Dec. 3, 1890. In an electric car, the combination, with the axles having worm-gears mounted thereon, said gears being provided with surrounding casings journaled on the axles and having extensions on which the ends of the armature shaft are journaled, of the channel bars connecting said casings, and an electric motor mounted on said channel bars in an inclined position, the inclined armature shaft having oppositely acting worms at each end engaging with the worm gears at points above and below the axles respectively.

448,914. Filament for Incandescent Electric Lamps; George Erlwein and Friedrich Gustav Adolf Heller, of Berlin, Germany, Assignors to Siemens & Halske, of same place. Application filed July 22, 1890. A filament for electric lamps, composed of a carbon core and a hardy fusible coating consisting, essentially, of a compound of carbon and manganese.

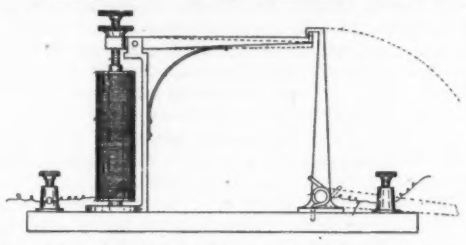
448,915 Filament for Incandescent Electric Lamps; George Erlwein, of Berlin, Germany, Assignor to Siemens & Halske, of same place. Application filed July 22, 1890. In incandescent electric lamps, a glow body consisting of a carbon filament for a core, and a coating of nitride of silicon incasing the said core.

448,916. Filament for Incandescent Electric Lamps; George Erlwein of Berlin, Germany, Assignor to Siemens & Halske, of same place. Application filed Oct. 25, 1890. A filament for electric lamps, composed of a carbon core and a coating consisting of phosphorus, combined with a hardly fusible metal.

448,920. Filament for Incandescent Electric Lamps; Friedrich Gustav Adolf Heller, of Berlin, Germany, Assignor to Siemens & Halske, of same place. Application filed July 22, 1890. A filament for electric lamps, consisting essentially of a small carbon rod or core with a covering of metallic chromium deposited upon the outside thereof.

448,927. Locomotive Engine; Ralph Peacock and Hermann L. Lange, of Manchester, England. Application filed Sept. 20, 1890. In vehicles driven by electric motors, the combination of the shaft of the armature of the motor and the driven axle of the vehicle with cranks and diagonally-disposed connecting rods connecting the said shaft with the said axle and axle boxes and guides in an inclined position.

448,936. Electrolyte for Galvanic Batteries; John J. Collins, of Washington, D. C. Application filed Sept. 30, 1890. The



No. 448,980.—ELECTRICAL PROTECTOR.

electrolyte consisting of an alkali, bichromate of potash or bichromate of soda, blue stone, an exciting acid, sulphur and sulphate of mercury.

448,953. Electric Belt; Willie C. Fuller, of Kirwin, Kan. Application filed Jan. 21, 1891. In an electric belt, the combination of a battery consisting of a number of cells suitably connected together, connecting-pieces secured to the opposite ends of the said battery sleeves upon the said connecting-pieces, and springs coiled around the said sleeves and extending through the slots therein, with contact-discs having studs projecting inwardly therefrom, upon which the sleeves are adapted to be held by means of the springs.

448,956. Electric Insulator; George H. Graham, of Ridgeland, and Thomas Gannane, of Chicago, Ill. Application filed Aug. 2, 1890. An externally screw-threaded insulator provided with a transverse groove in the end thereof, a screw-threaded collar fitted to the threaded portion of the insulator, and a loop or loops for clamping the conductor in the groove of the insulator

448,980. Electrical Protector; Isaac N. Miller, of Cincinnati, O. Application filed Oct. 28, 1890 An excessive current protector consisting of the heat coil having an expansive core, a lever pivoted in juxtaposition to one end to form a long and short arm, a screw-rod engaging the short arm of the lever and bearing against one end of the expansive core, and a pivoted contact-lever having a detachable engagement with the long arm of the screw rod-carrying lever and released from engagement therewith by the expansion of the core. (See illustration.)

448,998. Independent Electric Clock; Wm. S. Scales, of Everett, Assignor of two thirds to Jos. H. Clark, of Quincy, and Jno. F. Humphrey, of Boston, Mass. Application filed July 19, 1890. In an electric clock, a step-by-step train, a driving pawl, and an electromagnet and its armature that moves said driving pawl, a pendulum or equivalent and driving pawl moved by it, a propeller, and a circuit closer.

448,999. Secondary Electric Clock: Wm. S. Scales, of Everett, Assignor of two-thirds to Jos. H. Clark, of Quincy, and Jno. B. Humphrey, of Boston, Mass. Application filed Oct 20, 1890. In an electric clock, a train and a step-by-step driving mechanism therefor, consisting of a ratchet-wheel and pawl, combined with an electromagnet and its armature and a regulating member for the clock, both the armature and regulating member being adapted to actuate said pawl.

449,001. Method of Measuring Alternating Electric Currents; Oliver B. Shallenberger, of Rochester, N. Y., Assignor by mesne assignments to the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa. Application filed Dec. 26, 1888. The method of measuring the currents consumed in doing useful work in alternating-current electric circuits, which consists in employing the leakage current of the circuit to overcome the inertia of the meter and in operating the meter by the current flowing in excess of such leakage current.

449,002. Meter for Alternating Electric Currents; Oliver B. Shallenberger, of Rochester, N. Y., Assignor by mesne assignments to the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa. Application filed March 3, 1890. The combination, with a meter for electric currents, of a thermostatic brake.

449,003. Meter for Alternating Electric Currents; Oliver B. Shallenberger, of Rochester, N. Y., Assignor by mesne assignments to the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa. Application filed March 13, 1890. The combination, with an alternating current electric meter having an electric motor for actuating it, of an arresting device for normally preventing the operation of the electric motor, and a releasing device for operating said arresting device, and brought into action by the currents traversing the motor when they exceed a predetermined value.

449,035. Electrical Heater; John V. Čâpek, of New York, Assignor of one-half to Edward H. Johnson of same place. Application filed July 21, 1890. In an electrical heater, the combination of a casing or oven, a removable cover therefor, and a removable bottom consisting of the heating conductor and its supporting devices.

449,036. Electrical Heater; John V. Čâpek, of New York, Assignor of one-half to Edward H. Johnson of same place. Application filed July 21, 1890. An electrical heater, having a strip of heat-resisting insulating material and a flat zigzag heating conductor on one face of said strip.

449,044. Electric-Lighting System; Edward H. Johnson, of New York, Assignor to the Edison General Electric Company, of same place. Application filed Jan. 10, 1884. A main circuit having a number of electric lamps divided between two or more multiple-arc branches of said circuit, a circuit controller in said branches, having contacts arranged in a predetermined order for making and breaking the several branches to produce the desired visual effects, and an electric motor, also connected with the main circuit, for operating the circuit controller.